THE FAUNA OF BRITISH INDIA,

INCLUDING

CEYLON AND BURMA.

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REPTILIA and AMPHIBIA.

VOL. I.—LORICATA, TESTUDINES.

BY

MALCOLM A. SMITH, M.R.C.S., L.R.C.P. (London).

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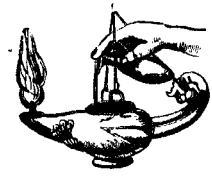

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AUTHOR'S PREFACE.

THE present volume is the first of the four which will deal with the Reptiles and Amphibians of British India. Volume II. will be devoted to the Lizards, Volume III. to the Snakes, and Volume IV. to the Amphibians.

As stated more fully in the Introduction (p. 13), the region which is covered by this work is not precisely conterminous with that of previous volumes published in this Series. It has been extended to include the whole of the Indo-Chinese Subregion, and is almost the same area as that included by Günther in his 'Reptiles of British India,' 1864.

At the suggestion of the Editor a general account of the structural characters and habits of the Order (or sometimes Family) will be found in the opening remarks to each group, so that the student may learn something of the group as a whole, and of its relationship to the rest of the Reptilian Class.

It need hardly be said that, with Mr. Boulenger's volume on the 'Reptilia and Batrachia' as a basis, the preparation of this work has been greatly facilitated. At the same time it is in no sense a *réchauffé* of his original publication, with the necessary additions and corrections. The whole has been rewritten, even to the smallest detail.

Certain modifications in classification have been adopted in accordance with more recent views, but the general plan of the work has not been greatly altered. Boulenger's methods of describing species have, with small modifications, been used. Several attempts have been made since 1890 to improve upon his system ; but these do not, in my opinion, give the same clear picture of the species, and they have not been adopted. Species have been described, and not individual specimens. Where a species is described for the first time a detailed description of the type is necessary, for types may get lost, or suffer through bad preservation. But when once the species is established there is nothing to be gained by continuing this method.

As regards nomenclature, the law of priority has been observed throughout. It has been carried into all groups, although the Rules of Zoological Nomenclature do not, at present, require it to be carried higher than genera.

The types of most of the species considered valid in this work, as well as those included in the synonymies, have been examined by me, and acknowledgement is due to those who have enabled this to be accomplished. Most of the work in connection with this volume has been done in the British Museum (Natural History), and I am indebted to Mr. H. W. Parker, Assistant Keeper (Reptilia and Amphibia), for placing the unrivalled collection in that Institution at my disposal. Lieut.-Colonel R. Seymour Sewell, I.M.S., Director of the Zoological Survey of India, Indian Museum, Calcutta, and Mr. S. H. Prater, Curator of the Bombay Natural History Society, have forwarded me the entire collections of Chelonians in their keeping for examination. Dr. Otto Wettstein has sent me many of the rarities described by Siebenrock, which are now in the Museum of Natural History, Vienna.

To Mr. N. B. Kinnear I am indebted for considerable help in compiling the historical account of Indian herpetologists.

Many other friends have helped me with information upon various points, particularly in regard to habits, and acknowledgements to them are recorded in the text.

A number of the text-figures are borrowed from Mr. Boulenger's volume. All the new illustrations are by Lieut.-Colonel W. P. C. Tenison, D.S.O., with the exception of the maps and text-figures 2 and 17, which are by Miss Joyce Townend.

Finally, I have to thank the Editor for his careful scrutiny of the text and general superintendence of the whole volume during its passage through the printer's hands.

MALCOLM SMITH.

March 1931.

GLOSSARY OF TECHNICAL TERMS.

(Anatomical parts explained in the text and text-figures are not included.)

Acetabulum.—The cavity for the reception of the head of the femur or thigh-bone.

Acrodont.—Having teeth which are firmly fixed to the edge of the jaw-bone.

Alveolar.—Belonging to the margin of the jaw where the teeth are (usually) situated.

Amphiarthrosis.—Articulation admitting slight motion.

Ankylose.—To grow together into one.

Areola.—That part of the epidermal shield of a Chelonian which exists at birth, and from which the new growth of horn proceeds.

Articulation.—The juncture or joint of bones.

Axillary.—Pertaining to the axilla or armpit.

Azygous.—Not one of a pair.

Bicuspid.—Having two points or cusps.

Bridge.—That part of the shell connecting the carapace and plastron.

Callosity.—An abnormal hardness and thickness of the skin.

Carinate.—Having a keel.

Centrum.—The body of a vertebra.

Choanæ.—The posterior nares.

Cloaca.—The common chamber into which the intestinal, urinary, and genital canals discharge.

Columella auris.—A delicate rod-like bone in the middle ear.

Concentric.—Having a common centre.

Condyle.—An articular prominence on a bone.

Coprodæum.—A part of the cloaca (see p. 29).

Copulæ.—The bones forming the body of the hyoid.

Cornua.—The "horns" or bones attached to the hyoid.

Costal.—Pertaining to the ribs.

Crenulated.—Feebly indented or crenate.

Cusp.—A point.

Cyclical.—Recurring in cycles or periods.

Denticulate.—Having small tooth-like projections.

Dimorphism.—The occurrence of two forms, distinct either in structure or coloration or both.

Disc.—The dorsal or ventral shield.

Egg-tooth.—The hard sharp prominence on the tip of the nose of oviparous reptiles with which the embryo breaks through the egg-shell.

Emarginate.—Opened in the form of a broad notch at the margin.

Facet.—A small flat and smooth articular surface of bone.

Fontanelle.—The space left between two or more bones: it may or may not fill up later in life.

Fossa.—A shallow depression or cavity.

Glaucous.—Of a bluish-green colour.

Gular.—Pertaining to the throat.

Homologous.—Having the same relative position; corresponding.

Homonym.—One and the same name for two different things.

Humeral.—Pertaining to the humerus or bone of the upper arm.

Hyoid.—The bone situated between the root of the tongue and the larynx, and giving attachment to the muscles of the tongue.

Imbricate.—Overlapping, like the tiles of a roof.

Inguinal.—Pertaining to the groin.

Intercalated.—Interposed.

Intercentrum.—A pad of cartilage or bone interposed between the centra or bodies of the vertebræ.

Juxtaposed.—Placed in apposition to, not imbricate.

Labyrinth.—The cavities of the internal ear.

Lanceolate.—Tapering at the end.

Lumbar.—Pertaining to the loin.

Mandible.—The inferior maxillary bone, or bone of the lower jaw.

Maxillary groove.—A name proposed for a well marked groove in the mid-line of the palate which is found in some species of *Trionyx*.

Mesial.—Situated in the middle line of the body.

Nares.—The nasal openings.

Neural.—Pertaining to the nerves or nervous tissue.

Nictitating membrane.—The thin membrane at the inner angle of the eye beneath the lower lid, capable of being drawn across the eyeball; the third eyelid.

Nodose.—Knobbed.

Nuchal.—Pertaining to the neck.

Occipital.—Pertaining to the occiput or back part of the head.

Ocellus.—A coloured spot surrounded by a ring of different colour.

Ossicle.—A little bone.

Oviparous.—Producing young by means of eggs which are "laid" or expelled from the body and subsequently hatched.

Ovo-viviparous.—Producing young by eggs which are incubated within the body of the parent, the nourishment for development being provided by the yolk. The young are born alive, the rupture of the enveloping membrane taking place at birth or immediately after.

Pectoral.—Pertaining to the breast.

Pentadactyle.—Having five fingers or toes.

Phalanges.—The bones of the fingers and toes.

Plantar.—Pertaining to the sole of the foot.

Pleurodont.—Having teeth fixed to the inner side of the jaw-bone.

Poikilothermous.—Said of animals in which the bodily heat varies with the temperature of the environment.

Polygonal.—Having many angles or sides.

Procœlous.—Vertebræ with the anterior end of the centrum or body concave.

Proctodæum.—A part of the cloaca (see p. 29).

Reticulate.—Arranged like a net.

Reverted.—Turned back.

Sclerotic plates.—A ring of bony plates which protects the sclerotic coat of the eyeball.

Scute.—A horny epidermal shield. In the Crocodilia it includes also the underlying dermal ossification.

Serrated.—Notched or toothed on the edge, like a saw.

Sigmoid.—Curved in two directions, like the letter **S**.

Stapes.—The *columella* of the auditory chain.

Sub-.—Somewhat; slightly.

Symphysis.—The union of two bones in the median plane of the body, such as the two halves of the lower jaw.

Tectiform.—Roof-like.

Temporal.—Pertaining to the temple.

Thecodont.—Having the teeth fixed in sockets.

Tricuspid.—Having three cusps or points.

Truncate.—Cut short.

Tympanic.—Pertaining to the tympanum or middle ear.

Urodæum.—A part of the cloaca (see p. 29).

Vacuity.—A space.

Vermiculate.—Marked with wavy impressions, like worm-tracks.

Vertebral.—Pertaining to the vertebræ or backbone.

Viviparous.—Producing living young, the nourishment for the developing embryos being provided through some form of placenta.

Zygapophysis.—The articular process of a vertebra.

CORRIGENDA.

P. 5, line 29. *For* "TENNANT *read* "TENNENT."

P. 9, line 33. *For* "1830" *read* "1803."

P. 21, footnote. For "*Geoemyda carinata*" read "*Geoemyda tricarinata*."

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INTRODUCTION.

SINCE the publication of Mr. Boulenger's volume on the Reptiles and Batrachians of British India, our knowledge in this branch of zoology has been greatly increased. Systematic collecting has been carried out in nearly all parts of the Indian Empire, and, except in the more inaccessible mountain districts, the herpetological fauna of the country is now pretty well known. In the exact distribution of the species, in their individual variation, in habits, life-histories, in fact in bionomics generally, a vast amount of investigation has still to be done, but for the mere collector in search of new species no great field remains. That the study of ecology should proceed more gradually is inevitable, for it is usually a slow and painstaking process, and can generally only be accomplished by those in the field. It is to be hoped that the present work, in which considerable attention has been paid to habits, will show by its omissions how much remains to be done in this direction, and will stimulate some to pay more attention to this fascinating branch of the subject.

Nomenclature, etc.

A strict application of the law of priority has led to innumerable changes both in generic and specific names since Boulenger's work was written. Stability has not yet been reached, but we have gone a long way towards it in the last thirty years.

Trivial names for species have been given only when they have become standardized by long usage. Vernacular names have not been attempted. The area dealt with is so large and the number of languages and dialects spoken in it so great that a complete list of them is quite beyond the scope of the present work. Moreover, native names are often unreliable, except for the commonest forms. The same species may have a different name in a different part of the country, even though the language has not changed, or the same name may be applied to two different species. After all, it is not to be wondered at,

for the country people have no great interest in reptiles except for the few that enter into their dietary. Vernacular names that are applied to groups and are the equivalent of those of generic or family rank are more reliable. It is only fair to state in extenuation of these remarks that my own experience is confined chiefly to Indo-China.

The synonyms given for species are, I believe, complete, except for those species that are widely distributed outside the region dealt with, in which case mention has been made of the fact.

The references given are not intended to be in any way complete. They have been chosen in so far as they are relevant to the text, and to enable the reader to know where to look for further information.

A scientific name in the synonymy, when followed by an author's name without an intervening comma, refers to the first published mention of that name. In the case of a species the type-locality follows and the name of the Museum in which the type is kept. A name followed by a comma and then the author's name indicates a reference subsequent to the original description.

History.

Three general works on the herpetology of British India have already been published. The first was 'The Reptiles of British India' by Dr. A. Günther, which appeared in 1864. The term India at that time was used in a much wider sense than it is to-day, and the area included by Günther is practically the same as that which is covered by the present work. The second was Theobald's 'Descriptive Catalogue of the Reptiles of British India,' a less pretentious work, published in 1876; it did not include the Sea-Snakes or the Amphibia, and the area dealt with was restricted to British India. The third is Boulenger's volume, which has been the standard work on Indian herpetology for the last forty years.

The following brief account of the best-known Indian and Indo-Chinese herpetologists—those who have lived in the country as well as have contributed by their writings to the subject—is given here for two reasons. It is devoted chiefly to the earlier workers. In the first place, it is of interest to know something of the lives of these men who worked so laboriously and under conditions so very different from those of to-day; and in the second, a knowledge of where they worked and collected is of value in locating where their material came from. The earlier authors did not pay such attention to exact locality as is demanded now, and often the types from which they drew up their descriptions are no longer in existence. But many of them made, or had made by native artists, carefully

executed drawings or coloured sketches, and these were sometimes used by other naturalists as a basis for describing new species. These drawings therefore, in their way, constitute the types. Fortunately, most of them have been preserved and are still accessible for examination.

RUSSELL, PATRICK, F.R.S., 1726–1805.

Born at Edinburgh on Feb. 6th, he graduated as a Doctor of Medicine at the University of that city. In 1750 he joined his elder brother at Aleppo, where he lived for 20 years. In 1781, at the age of 55, he joined his younger brother in India and resided principally at Vizagapatam, where he devoted most of his time and attention to the natural history of that country. In 1785 he was appointed botanist and naturalist to the East India Company, and was indefatigable in his researches, not only in botany, but in collecting, figuring, and describing the fishes and snakes of the country.

Patrick Russell was the pioneer of Indian ophiology. He was the first person in India to distinguish the harmless from the venomous snakes, which he did by a careful examination of their teeth ; he made also many experiments with animals to discover the toxicity of their poison. His two volumes on Indian snakes, containing brief descriptions and carefully executed coloured plates, were published in 1796 and 1801–1809 respectively. He applied only the vernacular names to his specimens. A number of his preserved snakes and his collection of dried skins, some of which are the specimens from which his drawings were executed, are now in the British Museum (Natural History). The dried skins are carefully mounted on strong paper, and many of them still show the living colours remarkably well. He died in London. A good account of his life, with a portrait, will be found in the second volume of his 'Indian Serpents,' which he did not live to complete.

HARDWICKE, Major-General THOMAS, 1756–1835.

Appointed to the Army of the East India Company as a cadet in the Bengal Artillery in 1778, and served in that corps till he finally commanded it. He retired from India in 1823 and died at Lambeth.

Hardwicke was an assiduous collector, not only of specimens in all branches of natural history, but also of coloured drawings of plants and animals. He bequeathed to the British Museum both his collections of specimens and drawings, the latter consisting of some thirty-two folio volumes, in which are 366 drawings of reptiles and amphibians. Most of the drawings were made by native artists from specimens

collected by Hardwicke himself, but some are copies of drawings in the collections of Buchanan-Hamilton and of Reeves.

A certain number of the drawings were reproduced in Gray's 'Illustrations of Indian Zoology,' published in 1830–35. This work was to have been accompanied by letter-press, and a sum of money was set aside by General Hardwicke for this purpose in his will, but, owing to a dispute, all his manuscript and notes were placed in chancery, where they still remain.

Most of Hardwicke's collecting was done in Bengal, at Dum-Dum and Calcutta, and in the United Provinces at Fatehgarh and Cawnpore. In 1796 he made a short expedition to Srinagar, in Kumaun.

HAMILTON, FRANCIS, formerly BUCHANAN, 1762–1829.

Born near Callander, in Scotland, he graduated at Edinburgh University in 1783 and entered the East India Company's service as an assistant-surgeon on the Bengal Establishment in 1794. He served 21 years in India and travelled extensively in that country as well as in Burma. In 1815 he retired and left India for good, and sometime later assumed the name of Hamilton on succeeding to property in Scotland. Hence the name Buchanan-Hamilton, by which he is frequently known.

Hamilton was primarily a botanist, and does not seem to have preserved many zoological specimens other than fish, but he made careful descriptions of mammals, birds and reptiles, and had coloured drawings of them prepared by native artists. The descriptions and some of the drawings are in the Library of the Asiatic Society of Bengal in Calcutta. Other drawings are in the Library of the India Office in London, and some, or copies of them, were given to Hardwicke and are now in the Hardwicke collection of drawings. Several were reproduced in Gray and Hardwicke's 'Illustrations of Indian Zoology.' Hamilton's sketches of reptiles appear to have been made while he was engaged on the statistical survey of Bengal during the years 1807–1814. The Bengal of those days was a much larger province than it is now. Hamilton visited the following districts:—Dinajpur, Goalpara, Rangpur, Purnea, Bhagalpur, Monghyr, Gaya, Patna, Shahabad, Allahabad, Gorakhpur, Fatehgarh.

REEVES, JOHN, 1774–1856.

Born at West Ham, in Essex. He was employed in the office of the East India Company's Inspector of Tea in London, and in 1812 was sent to China as an assistant. He subsequently became Chief Inspector of Tea to the Company's Establishment at Canton. He returned to England in 1831.

Reeves collected extensively in southern China, and had made by native artists under his supervision carefully executed coloured sketches of his specimens, which included mammals, birds, reptiles, fishes, crustacea, and molluscs. His collection of drawings and some of his specimens are now in the British Museum (Natural History).

HODGSON, BRIAN HOUGHTON, 1800–1894.

Born at Lower Beech, Prestbury, in Cheshire. He went out to Calcutta as a writer in the East India Company's service in 1818, and in the following year was appointed Assistant Commissioner in Kumaun. In 1820 he was transferred to Nepal as assistant to the Resident at Katmandu, and, with the exception of two years in Calcutta, served in that capacity and finally as Resident till 1843, when he retired to England. Returning to India two years later, he took up his residence at Darjeeling and lived there for thirteen years, finally returning to England in 1858. He died at Alderley on May 28th, 1894.

Hodgson did very little collecting himself, but kept several native collectors in his employ. He is best known in connection with mammals and birds, of which he made large collections and described many new species. In addition to collecting specimens Hodgson employed several native artists to make coloured drawings of all the animals in his collection. His sketches of reptiles and amphibians * from Nepal, eleven in number, are in the Library of the British Museum (Natural History). The snakes were described by Cantor in Proc. Zool. Soc. 1839. (See also Cantor.)

TENNANT, Sir JAMES EMERSON, 1804–1869.

Politician, traveller, and author. From 12th August, 1845, to December 1850 he acted as civil secretary to the Colonial Government of Ceylon and was much interested in natural history. His contribution to Indian herpetology will be found in his 'Natural History of Ceylon.'

CANTOR, THOMAS EDWARD, 1809–1860.

Cantor was of Danish descent and was born at Copenhagen on the 6th of January. He graduated as Doctor of Medicine at Halle University in 1833, and entered the service of the East India Company on the Bengal Establishment in 1835. He was surgeon to the Bengal Marine Survey from 1837 to 1839, and was with the British Forces at Chusan in 1840–1842. He spent some time in the Malay Peninsula, being stationed at Penang.

* The term amphibian as used in these volumes signifies a member of the class Amphibia or Batrachia.

Cantor was a keen naturalist and much interested in reptiles and amphibians. He collected extensively himself, but also obtained specimens from other sources, most of which have found their way into the British Museum (Natural History), partly through incorporation of the collection of the East India Company in 1860, partly through exchange with the Oxford University Museum in 1894. Whether he was careless himself in labelling his specimens, or, as is more likely, the mistakes occurred after his collections left his hands, is not known, but it is quite certain that many of his data as regards localities—particularly those labelled Penang—are incorrect, and these mistakes have led to errors as regards the distribution of those species. His chief contributions to Oriental herpetology are:—A paper on 'Indian Serpents,' published in the Proc. Zool. Soc. London, 1839; 'A Catalogue of Reptiles inhabiting the Malay Peninsula and Islands,' 1847; and 'Zoology of Chusan,' 1842. His coloured sketches of the 'Indian Serpents' with his notes are in the Bodleian Library, Oxford. This paper also includes a few snakes sent him from Nepal by Hodgson, the drawings of which are in the British Museum.

Cantor died at sea.

GRIFFITH, WILLIAM, 1810–1845.

Born at Ham Common, London, on the 4th March.

After taking his degree at London University, he was appointed to the Medical Department of the East India Company on the Establishment at Madras. Shortly afterwards he was sent to Tenasserim, and in 1835 was transferred to the Bengal Presidency and selected to accompany, as one of the botanists, the deputation to visit and report on the tea forests (as they were then called) of Assam. In this capacity he visited the Khasia Hills, and from there made a journey by himself to Rangoon *via* Sadiya, the Mishmi country, and Ava.

Two years later he was attached to Captain Pemberton's mission to Bhutan, and on his return to Calcutta in 1839 was sent to the army of the Indus, which he accompanied to Kabul. He returned to Calcutta *via* Simla in 1841, and was ordered to Malacca, but before proceeding there he was placed in temporary charge of the Calcutta Botanical Gardens till 1844, when he went to Malacca, where he died.

Griffith was primarily a botanist, but also made considerable collections of reptiles and other vertebrates at many of the localities mentioned; these came to the British Museum (Natural History) through the East India Company's Museum.

BLYTH, EDWARD, 1810–1873.

Born in London. He was appointed Curator of the Museum of the Asiatic Society of Bengal, arriving in Calcutta in Sept.

1841. For 21 years he was in charge of the Society's Museum, retiring in 1862.

During his long connection with the Asiatic Society, Blyth was instrumental in interesting a large number of people in natural history and inducing them to collect for the Society's Museum, though personally he was not able to do much field work. The specimens collected by Blyth himself are chiefly from the vicinity of Calcutta, the Midnapore district, and Khulna, on the edge of the Jessore Sunderbans in Bengal. In 1860–1861 he went to Burma for the sake of his health, and during two visits of some five months visited Akyab, Moulmein, Martaban, and Mergui. He died in London.

Blyth wrote many papers on Indian herpetology, most of which appeared in the 'Journal of the Asiatic Society of Bengal.'

BERDMORE, Major THOMAS MATHEW, 1811–1859.

Received a commission in the East India Company's Madras Artillery in 1830 and some years later joined the Staff Corps. He was appointed Assistant Commissioner in Northern Tenasserim, and sent many reptiles to Blyth from the Sitang Valley and also Mergui. In 1857 he was transferred to Martaban, where he died.

JERDON, THOMAS CAVERHILL, 1811–1872.

Of Scottish parentage, but born in the North of England. In 1835 he was appointed assistant surgeon in the East India Company's service on the Madras Establishment.

From 1836 to 1852 he served in the following places:—Ganjam, Jalna in the Deccan, Nellore, Tellicherry, and when on 6 months' leave visited the Nilgiri Hills.

Whenever opportunity offered he collected reptiles, and in 1853 published a 'Catalogue of Reptiles inhabiting Southern India' in the 'Journal of the Asiatic Society of Bengal' (vol. xxii). Most of the species described in this article are in the British Museum collection, but the drawings are lost.

In 1852 he was promoted Surgeon and appointed to the 4th Light Cavalry, then in the Saugor and Narbada territories (part of the present Central Provinces), and with his regiment took part in the campaign in Central India during the Mutiny. At the conclusion of peace he went on sick leave to Darjeeling for a year, and from there was posted to Thayetmyo, in Burma.

In the meantime he was transferred to the Government of India, and was placed on special duty for the purpose of writing his manuals on the Vertebrata of India. During the next five or six years he visited the Punjab, Kashmir, and all the hill stations of the Himalayas.

By 1868 the manuals on Mammals and Birds were published and the manuscript of the Reptiles sent to press, and on the 28th Feb. he retired and went on tour in Assam to the Khasia Hills. In June of the same year he went to England and died at Norwood two years later.

After his death the proofs of the volume on Reptiles were sent home, but what finally happened to them is not known. In 1874 several volumes containing his original drawings of reptiles were sold by auction by Messrs. Sotheby, Wilkinson and Hodge ; of these likewise no trace can be found.

BLANFORD, Dr. WILLIAM THOMAS, 1822–1905.

Born in London on 7th October. He was appointed in 1855 to the Geological Survey of India, and was engaged in field work in India and Burma till 1882, when he retired and went to London.

Blanford was a good all-round naturalist, and wrote many papers on mammals, birds, reptiles, and molluscs. His constant field work gave him ample opportunity of collecting specimens, which he gave both to the British Museum and to the Indian Museum.

In 1866–67 he worked in the Central Provinces—in Nagpur, Chanda, and the upper Godavari valley, and later paid visits to Khandala and the Nilgiris.

In 1872 he was appointed Geologist and Naturalist to the Persia Boundary Commission and travelled through Baluchistan and Persia as far as Shiraz. Accompanied by H. T. Elwes, he made a trip through Sikkim to the frontier of Tibet in 1872, while in the cold seasons of 1875–76–77 he was engaged in survey work in Western Sind, principally in the Kirthar range.

He died in London on the 23rd June, 1905.

FAYRER, Sir JOSEPH, Bart., F.R.S., 1824–1907.

Physician, surgeon, and scientist. His contribution to Indian herpetology is his 'Thanatophidia of India,' published as a second edition, enlarged and revised with numerous coloured plates, in 1874. Zoology was one of Fayrer's many hobbies, and his work upon the physiological action of the poison of the Indian snakes was undertaken in the time he could spare from his arduous duties of physician and surgeon.

MOUHOT, HENRI, 1826–1861.

Savant, artist, explorer, and naturalist. He travelled extensively in Siam, Cambodia, and French Laos between 1858 and 1861, finally succumbing to (?) malaria near Luang Prabang. The reptiles collected by him were reported on by Günther and are in the British Museum (Natural History).

THEOBALD, WILLIAM, 1829–1908.

Appointed an assistant to the Geological Survey of the Bengal Government in 1849, he was transferred for work in the Salt Range, Punjab, and was afterwards appointed third assistant to the Geological Survey of India in 1853. He retired in 1881.

Theobald was an excellent all-round naturalist, and among other branches of natural history devoted much of his time to reptiles and amphibians. He collected during his survey work in the Salt Range, in the western Himalayas, the Kangra Valley in the Punjab, Kumaun, the Narbada Valley, Gujarat, Lower Burma, and Tenasserim. His chief contributions to Indian herpetology are his 'Catalogue of Reptiles in the Museum of the Asiatic Society of Bengal,' 1868, and a 'Descriptive Catalogue of the Reptiles of British India,' 1876.

BEDDOME, RICHARD HENRY, 1830–1911.

Joined the military service of the East India Company on its Madras Establishment in 1848 and was posted to the 42nd Madras Native Infantry. In 1857 he was selected, on account of his devotion to botany and natural history, as chief assistant to Dr. H. Cleghorn, the first conservator of the newly-formed forest department, and finally succeeded him in 1869. He collected in the Himalayas, but is best known by the work he accomplished in the various hill ranges of Southern India, where he spent most of his service. He had exceptional opportunities during his inspection tours of the forests, and made very considerable collections of amphibians and reptiles, many of which he described himself. Most of his specimens were presented at different times to the British Museum; others are in the Indian Museum, Calcutta.

He retired in 1882 and died at Wandsworth on 23rd February, 1911.

ELLIOT, Sir WALTER, 1830–1887.

Born in Edinburgh on January 16th. He was appointed to the East India Company's service in the Madras Presidency in 1821, and served first as assistant collector at Salem. He was afterwards for many years at Dharwar in the southern Mahratta country, till that district was transferred to the Bombay Presidency. Later he was Commissioner for the Northern Circars till 1854. His collection of drawings of reptiles made during his long stay in the Madras Presidency was utilised by Günther when writing his 'Fauna of British India,' 1864, but unfortunately these cannot now be found.

He retired in 1860 and died at Wolflee in Scotland.

ANDERSON, Dr. JOHN, F.R.S., 1833–1900.

Born at Edinburgh on 4th October. He graduated at Edinburgh University in 1862, and in 1865 was placed in charge of the newly established Indian Museum, which post he held till he resigned in 1886.

In 1867 he accompanied Col. Sladen as naturalist on an expedition to Upper Burma and Yunnan, and in 1875–6 went with the second Yunnan Mission, but this time the expedition did not proceed beyond the borders of Burma. The results of these two expeditions were published in the 'Anatomical and Zoological Results of the Yunnan Expeditions,' 1878–9, in which Anderson deals not only with the amphibians and reptiles obtained, but also with those of Burma generally. During the winter of 1881–2 he made an expedition on behalf of the Indian Museum to the Mergui Archipelago and Tenasserim, principally for the purpose of obtaining marine specimens; but he also brought back considerable material in all branches of zoology, which was reported on in the 'Journal of the Linnean Society,' 1889 ("Fauna of Mergui").

GODWIN-AUSTEN, Lt.-Col. HENRY HAVERSHAM, 1834–1923.

Born at Teignmouth. He went out to India in 1851 as a subaltern in the 24th Foot (South Wales Borderers), and in 1857 was transferred to the Indian Survey Department as topographical assistant.

Nearly the whole of his service after that date was passed in Assam, where he was engaged in surveying little-known districts such as the Naga, Khasia, Miri, and Dafla Hills; also in Manipur. In these localities he collected many interesting reptiles, which he presented to the Indian Museum. He died in England.

STOLICZKA, FERDINAND, 1838–1874.

Born at Hochwald in Moravia. He graduated as Doctor of Philosophy at the University of Vienna in 1861, and was afterwards attached to the Austrian Geological Survey. In 1862 he was appointed palæontologist to the Geological Survey of India.

Stoliczka had a wide interest in natural history, and wrote many papers on mammals, birds, reptiles, and molluscs. He travelled extensively in the Himalayas, making two expeditions from Simla to Rupshu and the Valley of the Indus through Spiti and returning by Lahoul and Kulu. In 1869 he visited Akyab, Rangoon, Moulmein, Penang, and Singapore, returning by way of the Nicobar and Andaman Islands. Two years later he made a geological tour in Cutch, then spent some time at Darjeeling, and afterwards joined A. O. Hume's

expedition to the Nicobar and Andaman Islands. In 1873 he was appointed naturalist to the second Mission to Yarkand, but the hardships of this expedition proved too much for him, and he died on the way to Leh in 1874.

Wherever he visited, Stoliczka made collections in all branches of natural history, and most of his specimens are in the Indian Museum, Calcutta, or in the Museum of Natural History in Vienna. A full list of his contributions to Indian herpetology, 15 papers, 1868–1873, will be found in Ball's Memoir of his life, published in 1886 as a part of the 'Scientific Results of the Second Yarkand Mission.'

FERGUSON, Capt. HAROLD S., M.B.E., 1852–1921.

Most of his life in India was spent in Travancore. He was connected with the State Museum at Trivandrum from 1880 onwards, and from 1894 until his retirement from India in 1904 was Director of that Institution. Ferguson was keenly interested in all branches of natural history. He collected chiefly in Travancore and his contributions to herpetology deal chiefly with that State.

KELAART, Dr. E. F.

Kelaart was descended from the early Dutch colonists and was born in Ceylon. He was educated in England, and in 1841 was appointed staff assistant surgeon to H.M. Forces and first stationed at Gibraltar. From there he was transferred to Ceylon, and busied himself for some years with the natural history of the island, the outcome of which was 'Prodromus Faunæ Zeylanicæ,' published in 1852. He made large collections at Nuwara Eliya and sent his specimens to Blyth at Calcutta. He died on the voyage to England in 1860.

FEA, Signor L.

He collected for the State Museum of Genoa in Upper Burma, the Karen Hills, Pegu, and Tenasserim. The specimens were reported on in Ann. Mus. Civ. Genoa and Ann. Mag. Nat. Hist. between 1887 and 1893, and are distributed between Genoa and London.

SCLATER, WILLIAM LUTLEY.

Was Deputy Superintendent of the Indian Museum from 1887 to 1891. During that time he completely rearranged the collection of reptiles and amphibians, describing several new species. His 'List of the Snakes in the Indian Museum' appeared in 1891, of the 'Batrachia' in 1892. They contain a complete catalogue, with data, of the specimens in the collection at that time.

ANNANDALE, NELSON, F.R.S., 1876–1924.

Went out to India in 1904 as Deputy Superintendent of the Natural History Section of the Indian Museum, and was appointed Superintendent in 1907, which post he held until he died. He had already travelled widely before commencing his Indian career, and with H. C. Robinson undertook the Skeat Expedition to the northern part of the Malay Peninsula in 1899.

Under Annandale's energetic supervision the natural history section of the Indian Museum progressed rapidly. He inaugurated the 'Records' and 'Memoirs of the Indian Museum,' and in 1916 achieved one of the aims for which he had long worked, namely, the foundation of the Zoological Survey of India. By this change to an Imperial Department, zoology was placed on an official equality with botany and geology, and the increased funds at his disposal enabled him to organize zoological expeditions to all parts of the Indian Empire. He saw clearly the need of detailed systematic work, but it was only as a means to an end. Of the broader aspect of zoology, the relationship of a creature to its environment, the study of the fauna of an area or country as a whole, he never lost sight.

Annandale's interests were wide, both in zoology and anthropology. He was an untiring worker and a prolific writer. His contributions to herpetology were many and appeared chiefly in various Indian journals.

He died suddenly in Calcutta on 18th April, 1924.

FLOWER, STANLEY S., O.B.E., V.P.Z.S.

Flower's work in the Oriental Region was done during the years 1894–1898. For three years he was Director of the Museum in Bangkok, and during that time collected extensively in Siam. His chief contribution to the herpetology of the present region is 'Notes on a Second Collection of Reptiles made in the Malay Peninsula and Siam,' Proc. Zool. Soc. London, 1899.

WALL, Colonel FRANK, C.M.G., I.M.S.

Wall's service to Indian ophiology is too recent to need much notice here. His work in India extended from 1895 to 1925, and as a member of the Indian Medical Service he was stationed in many places. He collected in all parts of the Indian Empire, and by his energy and enthusiasm stimulated others to make collections for him. For many years he has been the chief authority on Indian snakes. He visited in turn every museum in India and overhauled their collections. He was a prolific writer, and managed to combine admirably the scientific and the popular sides of the subject. He was a

constant contributor to the 'Journal of the Bombay Natural History Society,' but wrote also for other Indian journals. The types of the numerous snakes described by him, together with many other specimens, are in the British Museum (Natural History); the rest of his collections are in the museums in India, principally in Bombay.

My own collecting, so far as this work is concerned, was chiefly in Siam between the years 1914–1924. Most of it was done by native collectors, who during that period visited every part of the country. I made one expedition to the Langbian Plateau in southern Annam, and another to the interior of Hainan. I am also indebted to many friends in Siam for sending me specimens from all parts of the country. The types of all my new species and a considerable part of my collection are in the British Museum (Natural History). Another large part of it, with many paratypes, is in the Museum of Comparative Zoology, Harvard University.

The greater part of Bell's collection of reptiles, which includes all the chelonians figured and described by him in his 'Monograph of the Testudinata,' is in the Museum of Comparative Zoology, Oxford University, and not in Cambridge, as stated by Gray in his introduction to Sowerby and Lear, 1872. A letter to this effect was written by Bell to Ann. Mag. Nat. Hist. (4) x, 1872, p. 462. He gives there also the history of his collection. Thanks to the kindness of Professor Goodrich the types of Bell's chelonians are now in the British Museum (Natural History).

Zoogeography.

The Limits of the Region.—A noteworthy change in the present work is that the limits of the area usually dealt with in the 'Fauna of British India' have been extended to include the whole of the Indo-Chinese Peninsula. The fauna of Siam, French Indo-China, and southern China is so closely allied to that of Burma that it would be scientifically incorrect to separate them from one another. Together with Assam and the eastern Himalayas they form a natural subregion, and it is only right that they should be considered as a whole. The inclusion of the new area adds about one-sixth to the total number of species that inhabit British India alone.

The southern limit of the Indo-Chinese Peninsula is at the Isthmus of Kra in lat. 10° N. From a strictly faunal point of view it would be more correct to put the line a little further north, say at lat. 12° N., for by shifting it to that extent about a dozen Malayan species of amphibians and reptiles,

which do not properly belong to the present work, would thereby be removed. The scope of this work, however, does not permit the change to be made. The northern limit of Indo-China is not so easily defined. The mountainous region of N.E. Burma and Yunnan, the eastern continuation of the Himalayas, extends steadily northwards into Tibet, whilst further east the subtropical region of Tonkin and southern China merge gradually into the temperate region of northern China. The determining factor there is climate. In the absence of any natural boundary, therefore, the line drawn must be an arbitrary one, and in selecting it I have endeavoured to find one that would include all the Indo-Chinese forms and at the same time exclude as many as possible of the Chinese. It need hardly be mentioned that only reptiles and amphibians have been considered for this purpose, and not other branches of zoology. Ornithologists, for instance, would prefer to see the line drawn farther north, but that this would not suit the present case can be shown by a single illustration. The herpetological fauna of the Province of Fukien—which is just north of my line—is given as 81 species of reptiles and 31 of amphibians *. The region has been well collected in, and the figures may be regarded as fairly complete. Of the total 112 species, 40 are Indo-Chinese and most of them occur over the greater part of that subregion, whereas 72 are Chinese. To include Fukien, therefore, would add nothing to the Indo-Chinese fauna, but would include a large number of Chinese species which do not properly belong to it.

The northern limit of the Indo-Chinese subregion, east of the Indian Empire, is therefore defined as follows :—Starting from the Nam Kiu Mountains in the extreme north-east of Burma, a line is drawn in a south-easterly direction to Yunnan-Fu ; from there it runs east to the Hung-shui Kiang, which it follows until it joins the Wu Kiang to form the Si Kiang or West River at Sun-chao-fu. It then follows the course of the West River to its termination in the sea at Canton. The island of Hong Kong is included. See Map of Zoogeographical Areas, pp. 18, 19.

General Considerations.—To the student of zoogeographical distribution there is probably no other region in the world that exceeds the present one in interest and in the richness of its fauna. Its total area is roughly 2,350,000 square miles, and within its borders every variety of elevation and climate is to be found.

Bounded on the north by the highest mountain range known, and including Northern India and Southern China, with their

* Pope, Bull. Amer. Mus. Nat. Hist. lviii, 1927, Art. 8, and 1931 (in prep.).

alternating seasons of summer and winter, it extends south to the equatorial zone, where the tropical heat is almost continuous. It includes the almost rainless area of North-West India and the hills of Assam, where the rainfall averages 450 inches in the year (Cherrapunji). An added element of interest is the fact that the great Deccan table-land of the peninsula of India, is a land of immense geological antiquity. There is no evidence to show that it has ever been submerged, although parts of the Himalayas and the Indo-Chinese Peninsula have been beneath the sea.

Blanford, in his 'Distribution of Vertebrate Animals in India, Ceylon, and Burma,' 1901, has dealt with the amphibians and reptiles, and in part the divisions given by him have been followed here. Unfortunately, the distribution of many of the genera as given in his work has been shown to be erroneous, due to incorrect determinations.

Compared with many of the higher vertebrates or with insects, the dispersal of amphibians and reptiles—at least of those that exist in present times—is a comparatively slow one. Snakes, especially some members of the family Colubridæ, roam more widely than lizards; amphibians wander least of all. Fortuitous dispersal by means of driftwood in rivers accounts for some cases, and the numbers conveyed in this way, when spread over centuries, are probably large. It is particularly liable to occur with snakes and lizards in times of flood, when they are forced to leave their natural habitat on the ground and take refuge in trees or on floating logs or masses of driftwood. It has been suggested that the Amphibia may owe their dispersal to the agency of birds, chiefly aquatic species, which carry the eggs attached to their feet from one pond to another. To me this seems highly improbable.

Man's agency also must be included among the methods of fortuitous dispersal. The deliberate introduction of a species, such as the Malayan Bull Frog (*Kaloula pulchra*), into Singapore from Siam, is rare, but the transportation of individuals in the cargo of ships is well known. The Geckoes that domicile themselves with man and inhabit the warehouses from which goods are shipped are well known in this respect, and the wide distribution of certain species of *Hemidactylus*, *Peropus*, and *Gekko* is due to this method of dispersal. In the study of zoological distribution such species are of no value. Apart from the Geckoes, however, it is rare for a species to be transported and to establish itself at any great distance from its native habitat, and where this has happened the fact can usually be recognized. The natural method of dispersal is a slow and gradual extension of range.

The dispersal of most of the species that exist to-day took place at a time when the geographical configuration of

the country was very different from what it is to-day. The number of species that are common to the islands of the Malay Archipelago and the continent of Asia is one proof of this; the present distribution of the Gharial (*Gavialis gangeticus*) and of the Freshwater Turtles, e. g., *Chitra* and *Pelochelys*, in river-systems that are not now connected together is another. It seems equally certain that the Indo-Chinese hill tortoises, *Testudo elongata* and *Geoemyda tricarinata*, did not extend their range into the peninsula of India (Chota Nagpur) by crossing the Gangetic Plain. True hill species for this reason are of greater interest and value in the study of zoological distribution than lowland forms. They are just as much isolated by the conditions under which they live as if they inhabited islands, and their occurrence upon widely separated mountain ranges is good evidence that a more direct connection between those ranges existed in past times than is to be found to-day.

Marked discontinuous distribution in a lowland form, either in a species or genus, appears to be due to the fact that in past times it inhabited the intervening area, and for reasons which cannot now be explained has died out. *Draco*, found in S. India and Indo-China, and *Cylindrophis*, found in Ceylon and Burma, each being absent in the intervening area, are cases in point. *Rana cyanophlyctis* is another. This frog occurs over the whole of India proper and extends into Assam; it is absent from Burma, but a single specimen was captured by Annandale in the Inland Sea near Singgora, in peninsular Siam. The status of the agamid lizard *Cophotis*, which occurs in Ceylon and Sumatra, is doubtful, and for the present may be disregarded.

The absence of certain species of reptiles and amphibians in the southern part and their presence in the northern part of the Malay Peninsula and in the islands of the Archipelago has been commented on by several writers; but if genera and families are considered the gap can be greatly extended. Among the snakes are *Stoliczkaia* in Upper Burma and in Borneo, *Opisthotropis* in eastern Indo-China and in Borneo and Sumatra. The occurrence of Russell's Viper in Java is doubtful, but it has recently been found on the islands of Flores and Komodo; in Indo-China it does not extend south of lat. 14° N. The agamid lizard *Physignathus* occurs in Cambodia and in the Australian region, and the distribution of *Hyla* in the Old World is nearly similar, except that it does not occur so far south in Indo-China. The immense geographical changes which took place in the Indo-Chinese and Malaysian regions in late Tertiary and Post-Tertiary times may explain these phenomena.

Zoogeographical Divisions.—The Oriental Region of zoologists includes the peninsulas of India and Indo-China, the Malay Peninsula, and the East Indian Archipelago. It is

the smallest of the six regions into which the earth has been subdivided for the study of zoological distribution. It comprises three subregions, namely the Indian, the Indo-Chinese, and the Malaysian. With the latter and the faunal divisions of the East Indian Archipelago the present work is not concerned.

The Indian Subregion includes the peninsula of India as far east as Bengal—at about longitude 90°—and south of the Himalaya Mountains. It includes three distinct faunal areas. That in the north-west should not, strictly speaking, be included in the Oriental Region at all; it belongs to the desert or semi-desert country of south-western Asia, and is a part of the Palæarctic Region. The mountainous parts of Ceylon and south-western India have a singularly rich and distinct fauna, more than twenty genera of amphibians and reptiles occurring in this area which are not found elsewhere. It has been named by some zoogeographists the Ceylonese Subregion. The rest of the peninsula of India as far north as, but not including the Himalayas, has no such distinctive faunal characters; most of its genera are widely spread over the Indian Subregion, if not over the whole of the Oriental Region.

The Indo-Chinese Subregion includes the peninsula of Indo-China, the Eastern Himalayas, southern Yunnan, and the extreme south of China. Its western boundary, as just stated, is in eastern Bengal, its southern at the Isthmus of Kra. The fauna of this area is more homogeneous in character than that of the Indian. Many of its genera and species extend south into the East Indian Archipelago and east as far as Formosa. On the whole it is more intimately connected with the Malaysian Subregion than with the Indian.

Divisions of the two subregions into smaller areas can be recognized, the conditions which determine them being temperature, rainfall, altitude, and the presence or absence of forest. Deforestation by man's agency has played a large part in the distribution of species. Within comparatively recent years most of the Western Ghats from Bombay south to Karwar have been almost completely denuded of forest. Similar destruction has taken place in the neighbourhood of Chaibasa, in Orissa, owing to the rise of industrial occupations. In parts of Tonkin and Hainan steady deforestation appears to have been carried on for centuries and is still continuing; huge areas of what must have been at one time thick forests are now only grassy slopes. Many other districts could no doubt be instanced. Altitude in itself, provided that suitable habitats are available, does not prevent the occurrence of lowland species. Many are to be found on plateau-lands at 4000 and 5000 feet altitude, and sometimes even higher.

The following areas are distinguished :—

THE INDIAN SUBREGION.

1. *The Desert Area of North-West India.*—This includes Baluchistan, the North-West Frontier Province, the Punjab,

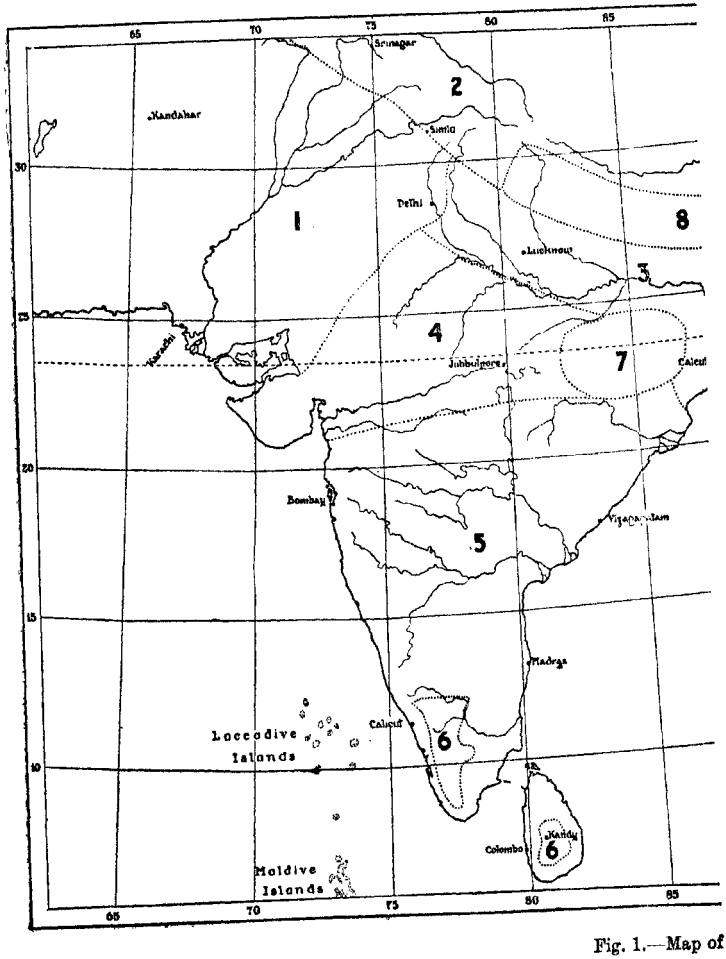
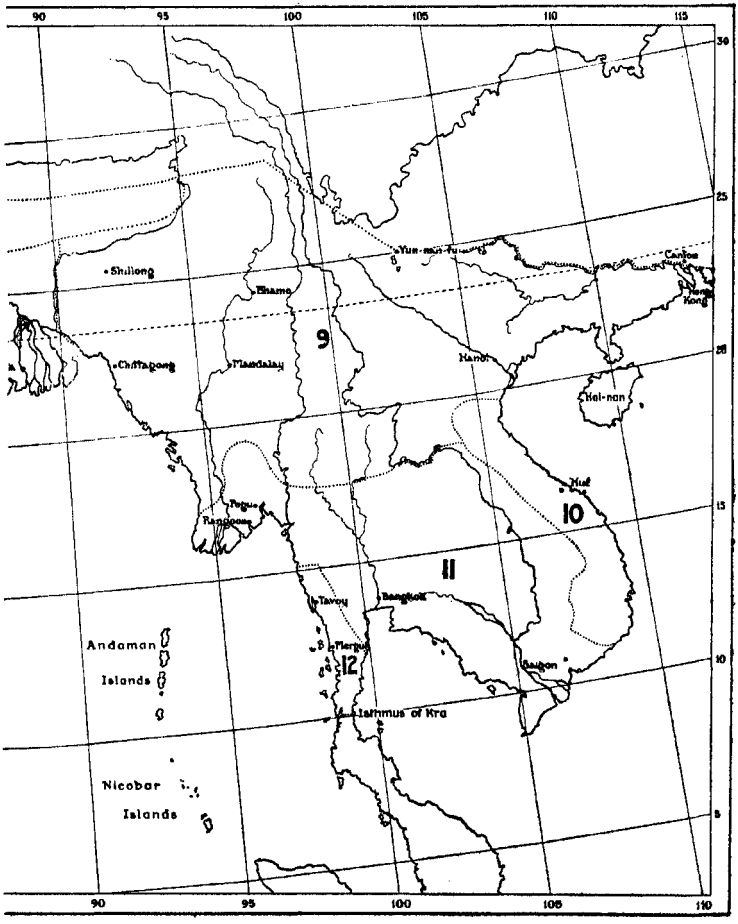


Fig. 1.—Map of

1. The Desert Area of North-West India.
2. Kashmir and the Western Himalayas.
3. The Gangetic Plain.
4. Central India.
5. The Deccan.
6. The Mountains of the Malabar Tract and Ceylon.

western Rajputana as far as the Aravalli range, and Sind. The area is desert or semi-desert except near the rivers. The rainfall is small; in the Punjab it does not exceed 20 inches in the year, and parts of Sind and Baluchistan are almost rainless. The interior of Baluchistan is from 3000



Zoogeographical areas.

7. The Chota Nagpur Area.
8. The Eastern Himalayas.
9. The Trans-Himalayan Mountainous Area.
10. Annam.
11. The Great Plain of Indo-China.
12. Tenasserim and Peninsular Siam.

to 6000 feet above sea-level. The fauna of this area is essentially a desert one and resembles that of the desert region further west. The majority of the genera that occur in it are not found elsewhere in India. Their adaptive modifications to withstand extreme heat and drought are of great interest. Lizards are much more abundant than snakes, and amphibians, as would be expected, are almost absent.

2. *Kashmir and the Western Himalayas* (as far east as, but not including, Nepal) may be considered together. Most of the country is mountainous and highly elevated, and amphibians and reptiles are scarce. The few species that are recorded from it are stragglers from the surrounding areas.

3. *The Gangetic Plain.*—The great Indo-Gangetic Plain of Northern India extends from the valley of the Indus in Sind to the right bank of the Brahmaputra in Bengal. Geologically it separates the Himalayas from the table-land of the Peninsula. Faunistically it is divided into two areas, a western or desert area, which has just been dealt with, and an eastern one, termed here the Gangetic Plain, through which flows the Ganges. Its fertile alluvial soil is for the most part cleared and cultivated and thickly populated. It has no forest, the land when not cleared being covered by high grass. At its western end the rainfall is small, from 20 to 30 inches ; on the Bengal side it is much heavier, from 50 to 100 inches. Its fauna is that of the non-mountainous parts of the Indian Peninsula.

4. *Central India.*—This name is given to the tract of country lying between the Gangetic Plain and the Deccan, and bounded on the west by the Aravalli range and on the east by the Chota Nagpur area. Faunistically it cannot be separated from the Deccan, but in order to avoid confusing it with the true Deccan area, it is best kept apart.

5. *The Deccan.*—The great part of the peninsula of India between 12° and 21° north latitude is formed by the central table-land of the Deccan. It is bordered on the west by the Western Ghats, a flat-topped range of hills, rising abruptly from the Arabian Sea and running more or less parallel with it, sloping more gradually on the side of the Peninsula. The rainfall along the coast is heavy—from 100 to 200 inches annually—where the high mountains intercept the moisture-bearing winds of the S.W. monsoon ; inland it is considerably less.

The discontinuous line of mountain country facing the Bay of Bengal and known as the Eastern Ghats has not the same unity of structure as the Western Ghats.

A notable feature of the peninsula of India is that all the main rivers run east. The three longest, namely the Godavari, the Kistna, and the Cauvery have their origin in the Western Ghats, almost within sight of the Arabian Sea, and discharge their contents into the Bay of Bengal.

6. *The Mountains of the Malabar Tract and Ceylon.*—Although geographically a part of the Western Ghats, the hills south of lat. 12° differ markedly from those north of it, both in geological structure and general physiography. Together with the mountains of Ceylon they constitute a distinct faunal region, more than 20 genera of amphibians and reptiles being peculiar to it. The chief hill-ranges of this area in the peninsula of India are the Nilgiris, the Anamalais, the Palnis, and the Cardomom Range. They rise to a considerable height, the Nilgiris and Anamalais having small plateaux some 7000 feet above sea-level. Dodabetta, 8700 feet, is the highest peak in the peninsula of India. Most of the area is well forested. The rainfall is heavy, between 90 and 150 inches, and owing to its approximation to the Equator, seasonal changes in it are not so marked as they are further north.

7. *The Chota Nagpur Area.*—This includes Bihar south of the Gangetic Plain, the northern part of Orissa, and the eastern part of the Central Provinces. The area is mountainous, and except in the neighbourhood of Chaibasa, where industrial occupations have sprung up in recent years, is heavily forested and sparsely populated. The average rainfall is between 50 and 70 inches in the year, being higher near the coast, lower inland. Its fauna is incompletely known, but is of interest in that it contains a Himalayan and Assamese element *, although separated from the mountains of those parts by the Gangetic Plain. The highest peak in the Chota Nagpur area is Parasnath Hill, an isolated mountain of 4800 feet altitude, in its north-eastern corner ; the nearest point to it in the Himalayas is the Nepal foot-hills nearly 200 miles away.

The Indo-Chinese Subregion.

8. *The Eastern Himalayas.*—These extend from the western frontier of Nepal to the termination of the range at the bend of the Brahmaputra. The area is more tropical and more heavily forested than the Western Himalayas, conditions which have no doubt influenced the faunal distribution. The wooded slopes of the Himalayas form a belt of variable breadth between the Gangetic Plain and the Tibetan plateau. The

* *Testudo elongata, Geoemyda carinata, Trachischium tenuiceps,* and *Lygosoma sikkimense.*

warm deep valleys of the plains penetrate far into the mountains, and it is possible within a few hours' climb to pass from a tropical and lowland fauna into one that is entirely montane. The hill fauna resembles that of Assam and Upper Burma.

9. *The Trans-Himalayan Mountainous Area.*—This includes the hills of Assam east of the Brahmaputra, the whole of Burma except the lowlands in the south, southern Yunnan, the northern part of French Indo-China, and the northern part of Siam. The area is one of precipitous hills and deep valleys. The trend of the ranges is north and south, in strong contrast to that of the true Himalayas where they run east and west. Through the region where the break occurs come the big Tibetan rivers. The fauna of this large area is best considered together, although it varies in different parts of its range. The complete change in the direction of the mountain ranges which occurs at the bend of the Dihang-Brahmaputra does not coincide with any change in the faunal characters, and in this respect Assam and the Eastern Himalayas cannot be separated. The fauna of Tonkin contains a Chinese element. The whole area, however, is still imperfectly known.

10. *Annam.*—The narrow strip of country known by this name which faces the China Sea is entirely mountainous, except along the coast, an almost unbroken range of hills extending from Tonkin in the north to the Langbian Plateau in the south. Many species are peculiar to these mountains, but no genera; the fauna, however, is still incompletely known. The occurrence of Burmese and Siamese hill-forms in this area is natural, since the mountains of French Laos and northern Siam are continuous with those of Annam. The connection of the Langbian Plateau with the mountains of the Malay Peninsula is more interesting. Two species of scink, namely *Lygosoma stellatum* Blgr. and *L. bampfyldei* Bartlett, which have been found in the Larut Hills, Perak, occur also on the Plateau.

11. *The Great Plain of Indo-China.*—This area includes the lowlands of Burma south of Prome and Toungoo and at the mouth of the Salween, and the great plains of Siam, Cambodia, and Cochin China. The country is for the most part flat and composed of alluvial soil deposited by the rivers. It is more or less populated and cultivated. The area in Eastern Siam, which is shut off from Central Siam and Cambodia by the Dong Pia Fai and the Dong Rek mountains, is slightly more elevated—from 200 to 300 feet—than the rest of the plain. This part of the country is sandy and barren, with thin shadeless forest, chiefly of bamboos, and is subject, like the rest of the area, to drought in the dry season and floods in the rains.

The wet monsoon is from May to October. The annual rainfall in the Pegu area is from 100 to 125 inches, in Bangkok it is about 55, in Cochin China from 50 to 90 inches.

Two brevicipitid genera of frogs, both monotypic, namely *Glyphoglossus*, which is almost indistinguishable from the Indian *Cacopus*, and *Calluella*, are peculiar to this area (Burma and Central Siam); the other genera which inhabit the plains are widely distributed.

12. *Tenasserim and Peninsular Siam.*—The fauna of this area, particularly of the southern part, contains a considerable Malayan element. The mountain-chain which extends down the Peninsula, by interrupting the rain-bearing clouds of the south-west monsoon, has a marked influence upon the country on either side of it, and, incidentally, upon the fauna. On the Burmese side the rainfall is greater, the yearly average being between 150 and 200 inches, the country more heavily forested, and the conditions approximate more closely to those of the Malay Peninsula. In consequence the Malayan fauna is more abundant, and extends further north upon the Burmese side than upon the Siamese.

Hainan.—The island of Hainan covers roughly 1300 square miles. The north-eastern portion is an undulating plain, now for the most part treeless and covered with grass-land. The central and southern area is mountainous, the highest peak being the Five Finger Mountain, with an altitude of 6000 feet. The fauna of the plain is similar to the lowland fauna of the Indo-Chinese Peninsula; that of the mountainous region is Chinese in origin or is peculiar to the country.

The Andaman and Nicobar Islands form a part of the mountain range that once extended from Cape Negrais in Lower Burma—a continuation of the Arakan Yoma—to Achin Head in Sumatra. Submergence of all except the highest peaks took place no doubt when the continent of Asia was separated from the East Indian Archipelago. Most of the islands are densely forested. The Andamans contain an impoverished Burmese fauna; that of the Nicobars approximates to the Sumatran type.

Miscellaneous Remarks.

The spelling of place-names used in these volumes is that of the Indian Postal Guide and the Gazetteer of India.

The measurements given for species are the largest of which there is an authentic record. Gigantism, however—that is to

say, individuals that considerably exceed what appears to be the normal size,—is not infrequent in amphibians, and in snakes among the reptiles. It appears to be much more prevalent in females than in males, but further information upon this point is badly needed. Where cases of gigantism are suspected mention is made of the fact in the text.

In constructing the keys of identification, external characters have been utilised as far as possible, and, supplemented by the description, should, if properly used, enable the student to identify most of the species met with. But for genera and families, internal characters cannot be ignored. Classification depends chiefly upon them. Better and more complete methods of examination have provided us with characters that were not available to Boulenger in 1890, and the value of some of those used by him have been considerably modified. The dissection required to discover them for ordinary purposes is not difficult and the instruments needed are few. A scalpel or two, some sharp-pointed scissors, dissecting forceps, callipers, a rule for taking measurements, and a good hand-lens are sufficient.

Preservation of Specimens.—The preservation of crocodiles of any size for museum purposes is not easy. The skull is by far the most important part of the creature, and this should always be kept. It should be cleared of all flesh that is attached to it, and then dried in the sun, or smoked, but not burnt, over a fire. The skin will keep only if cleared completely of fat and flesh. This is a long job; to skin and clean properly a beast of 12 feet long will occupy two men at least two full days. After cleaning, the skin can be rubbed with alum (1 part) and salt (3 parts), or ashes, and dried in the sun.

The preservation of tortoises is easier. If small they can be dropped straight into spirit—methylated spirit will do—of about 80 per cent., after making incisions in the axilla and groin to allow the alcohol to penetrate. Larger specimens can have the head, limbs, and tail removed and put into spirit, and the shell can be cleaned and dried. Another method is to inject the specimen with neat formalin, or, after removing the viscera, to pack the body with cotton-wool soaked in 4 or 5 per cent. formalin. As, however, formalin makes the specimen stiff, care must be taken to extend the limbs and head before this takes place. The specimen can then be carried dry and will keep for years. Soft-shelled turtles must be preserved in spirit or weak formalin. Unless the formalin is made very weak, however (about 3 per cent.), the specimens will become hard and the green coloration which so many of them have will become blackish. Formalin is cheap and convenient to carry

in the field, and, if used sufficiently dilute and the specimens do not remain in it too long, gives good results. It does not, however, compare with alcohol.

The importance of giving the exact locality where the specimen has been collected cannot be too strongly emphasized. When the locality is not likely to be found on the map, its position with regard to the nearest town of note should be given, or its approximate position in longitude and latitude can be stated. Strong paper labels written with pencil will keep in spirit or formalin if not chafed. Chinese ink is better, but it must be allowed to dry for 12 hours before being immersed. The coloration of the living creature should always be noted. Certain colours, such as reds and yellows, usually fade completely after a time; blacks and browns remain unchanged.

The killing of a large tortoise or turtle is not always an easy matter. A simple method is to wait until the head is extended, and then deliver a smart blow with a hammer and chisel, or its equivalent, upon the neck so as to break the cervical vertebræ. Most chelonians can live for months without food, and can, therefore, be conveyed alive. If this is done they should be allowed the chance of drinking all they want every few days.

Class REPTILIA.

Reptiles are cold-blooded vertebrates, which breathe by lungs throughout their existence and have the body covered with scales; the skull articulates with the vertebral column by a single median occipital condyle. By this combination of characters that diverse collection of creatures which we call reptiles can be distinguished from all other vertebrates.

The evolution of the reptiles was rapid. That they arose from the amphibians and that they gave rise in their turn to the birds and mammals seems now fairly certain. They were the dominant group of vertebrates during the Secondary or Mesozoic period, and they reached their maximum and most diversified development at that time. Most of the orders were established by the end of the Triassic and some became extinct at that time. Of the 19 orders into which they are usually divided only 4 survive to-day. They are :—

I. The Testudines (Chelonians: Turtles, Tortoises, and Terrapins).

II. The Rhynchocephalia, now confined to a single species, the Tuatera (*Sphenodon punctatus*) of New Zealand.

III. The Loricata or Crocodilia (Gharials, Crocodiles, Alligators, and Caimans).

IV. The Squamata (Lizards and Snakes).

Sphenodon punctatus is the most primitive of the living reptiles, whilst the chelonians and crocodilians are merely the survivors of orders that were once more diversified and more widely distributed than they are to-day. The Squamata are the most recent, and are still on the ladder of ascent. In their variety of form, genera, and species they far outnumber the others. The distinguishing characters of the three orders with which this work is concerned are too well known to need description.

The following are the chief anatomical characters of reptiles in general, with particular attention to the Oriental species :—

Skull.—The skull is a complicated structure and is composed of many bones. Its shape and the number of bones which enter into its formation vary enormously, and a more detailed discussion of it is reserved for the introductory remarks to the various orders. A scheme for the primary classification of reptiles, based upon the architecture of the temporal region, was first definitely formulated by Osborn in 1903, and in a modified form is now generally accepted. In the most primitive

reptiles, as in their amphibian ancestors, the temporal region was completely roofed over. In the course of evolution one or more fossæ or vacuities appeared. *Sphenodon punctatus* is the most perfect example of the group possessing two temporal fossæ, a supratemporal and a lateral temporal (Diapsida), and to this subclass the Loricata also belong. Lizards have lost the lower temporal arch (Synapsida), and snakes have gone a step farther and have lost the upper arch. In the Testudines the temporal region is completely roofed over in the marine turtles, secondarily emarginated, not perforated, in the others (Anapsida). The most recent account of this system of classification will be found in Williston's 'Osteology of the Reptiles,' 1925. The position of some of the reptilian orders, however, is still debatable, and the scheme adopted there, which was written up after Williston's death, can only be regarded as a tentative one.

The mandible or lower jaw is built up of a number of bones, and articulates with the cranium by means of the quadrate bone. In the Crocodilia and Testudines this bone is firmly fixed to the cranial arches; in the Squamata it is movable, with the result that they are able to swallow entire larger objects in proportion to their size than are the two first-named orders. This mobility of the jaws has been carried to an extreme degree in snakes, and most of them are able to swallow prey considerably larger than the normal size of their mouths.

Teeth.—The teeth of reptiles are to be found on the premaxillary and maxillary bones, the bones of the palate, and on the dentary and coronoid bones of the lower jaw. Their position varies in the different groups. Only in the chelonians are they absent. They may be set in sockets (thecodont) as in the Crocodilia, or fused to their supporting bone (acrodont or pleurodont) as in the lizards and snakes. Only the Agamidæ among the lizards are acrodont, and in them there appears to be no replacement of the teeth after maturity. But with other reptiles they are shed and replaced periodically.

Vertebral Column.—The number of bones in the vertebral column or backbone varies enormously. It is fewest in the chelonians, in which it may be reduced to 36 (*Terrapene*), and most in the snakes, some of the pythons having as many as 400. Each vertebra is composed of a body or centrum and a neural arch which protects the spinal cord. Intercentra, when present, are small. Projections from the vertebræ called processes or apophyses serve for the attachment of muscles or ligaments, and for articulation with the adjacent vertebræ and the ribs. Ribs, more or less developed, occur on all the precaudal vertebræ. A sternum is present only in *Sphenodon* and in the lizards among the recent orders.

The protective power of breaking off the tail is possessed by many lizards (Gekkonidæ, Lacertidæ, Anguidæ, Scincidæ). The split occurs transversely across the body of the vertebra and neural arch, and not between the vertebræ, as one might expect. The new tail which grows afterwards has no vertebræ; it is only a rod or tube of fibro-cartilage, and the scales which cover it usually differ from those of the normal organ.

Limbs.—Reptiles are tetrapodous, and the limbs, when present, are of the primitive pentadactyle type. Some lizards are limbless (Anguidæ, Dibamidæ, and some of the Scincidæ), and have the body serpentiform in shape, but pectoral and pelvic girdles, or vestiges of them, are always present. Snakes have no pectoral girdle, but in some (Typhlopidæ, Leptotyphlopidæ, Ilysiidæ) vestiges of a pelvis and, in the Boidæ, of hind-limbs also can be found.

Our knowledge of the soft parts is naturally derived from the living forms.

Circulation, etc.—The heart is three- or four-chambered. Two auricles are always present, and in the Crocodilia the ventricle is also completely divided into right and left compartments. In other reptiles it is only incompletely divided. There is no conus arteriosus, and the right and left aortic arches persist.

The red blood-corpuscles are oval, nucleated, and biconvex. The body temperature is variable (poikilothermous) and is dependent upon that of the surrounding medium. For this reason reptiles are most active in warm places, and their activity becomes progressively less as the cold increases. Those that live in temperate regions hibernate in the winter. Complete hibernation extending over a period of months may occur in the northern part of the Oriental Region, where the cold is sufficiently intense. This is always so in the mountainous areas, but even in the lowland districts as far south as the Tropic of Cancer some species undergo a period of incomplete hibernation. Amphibians are able to withstand extreme cold better than reptiles.

Æstivation, which is the opposite to hibernation, takes place for an entirely different reason. It may occur in the crocodiles and mud-turtles when their water-supply dries up owing to the cessation of the rains, in which case they bury themselves in the mud and remain there until set free by the advent of the wet monsoon.

Body-cavity.—The body-cavity of reptiles is always more or less completely divided into compartments. Only in the Crocodilia is there a complete transverse partition separating the heart, lungs, and liver from the abdominal cavity. This partition is partly muscular, and functions in respiration like the diaphragm or midriff of mammals, but morphologically

it is quite different. The heart is always completely enclosed in a pericardium.

All crocodilians, chelonians, and lizards have two lungs. In the two first-named they are highly developed spongy structures. In those lizards which have developed an elongated snake-like body the lungs are usually asymmetrical, one being larger than the other. In snakes this is always so, the left lung being much smaller than the right.

Cloaca.—The cloaca is the terminal part of the gut, and is the common chamber into which the genital ducts and the urinary and alimentary systems open. Its external opening is transverse in the lizards and snakes, more or less longitudinal in the chelonians and crocodilians. It is more or less divided into compartments—namely, the proctodæum, urodæum, and coprodæum,—the position and extent of which vary somewhat with the different orders.

The cloacal opening leads into the proctodæum, and contains the copulatory organs. Into the urodæum open the ureters, vasa deferentia, oviducts, and in the chelonians and in most lizards the bladder, a structure which is absent in crocodiles and snakes. The coprodæum is for the storage of fæces, and exists as a separate chamber in lizards and snakes; in the chelonians and crocodilians it is confluent with the urodæum.

The urine of the chelonians and crocodilians is fluid; in the lizards and snakes it is more solid, due to the fact that it contains a large amount of crystals of insoluble urates.

Copulatory organs.—These are absent in *Sphenodon*, but are present in the other groups.

In the crocodilians and chelonians a median unpaired penis arises from the ventral wall of the proctodæum and is extruded through the anterior end of the cloacal slit. On its dorsal surface there is a deep groove which leads back to the openings of the seminal ducts. In the Squamata the copulatory organ is paired. Each organ consists of a tube of erectile tissue, which is protruded by being turned inside out, like the finger of a glove, through the side of the cloacal slit. It is retracted by special muscles, which are part of the tail musculature. Each hemipenis has a groove on its surface for the conduction of the seminal fluid. Only one organ is inserted at a time, but which one is immaterial, and depends entirely upon the side the male happens to be at the time the act is performed. Fertilization is internal.

Ovo- and viviparity.—Most reptiles are oviparous and lay eggs which are hatched by the heat of the sun; but in some species of lizards and snakes development is carried on in the body and the young are produced alive (ovo-viviparous and viviparous). True viviparity, in which some form

of placentation occurs, is at present known in a few species only. It was described first of all in *Chalcides* by Giocomini in 1891, and has since been shown to exist in some species of Australian *Lygosoma* and in *Tiliqua* (Weekes, 1925–1927) and last year (1929) by the same author in two species of Australian snakes (*Denisonia*). It will no doubt be found to be much more prevalent when more viviparous species are examined. Probably no definite line between ovo-viviparity and viviparity can be drawn; for an exact definition of these terms the reader is referred to the Glossary. Oviparity and viviparity have no taxonomic value; species in the same genus may produce young by either method.

Egg-tooth.—The embryos of crocodiles, chelonians, and of the oviparous species of lizards and snakes are provided with a sharp calcareous "egg-tooth" on the top of the snout to enable them to break their way through the shell. This is shed a few hours after birth. Much interesting work upon the presence or absence of an egg-tooth and the mode in which the young are developed can be accomplished in the field.

Skin.—The skin is covered with horny scales or scutes which are formed from the epidermis; rarely it is naked (Amphisbænidæ). The shedding of the skin (ecdysis) takes place periodically in the Squamata; but whereas in the snakes and in some snake-like lizards it is shed in one piece, in the lizards it comes off in flakes. The epidermal horny layer in the chelonians and crocodilians is not shed periodically, but wear and tear is made good imperceptibly. Ossified portions of the cutis (osteoderms) occur in the lizards. They are to be found on all the scales of the body in the Anguidæ and Scincidæ, but in other families, when present, they are restricted to certain areas.

The skin is devoid of glands except those that are provided for sexual purposes. These, the sex-, or scent-, or musk-glands, vary in number and position in different groups. The femoral and preanal pores of lizards are not connected with glands, but are tubular ingrowths of the epidermis. They occur in certain genera only, and often only in the male of the species. Their excretion, which is composed largely of the debris of epidermal cells, is most obvious in the male at pairing time, but field observations upon this point are needed.

The power of changing the colour of the skin is in the reptiles restricted to the lizards.

Tongue.—A tongue is present in all reptiles. In the crocodilians and chelonians it is short and broad and is attached to the floor of the mouth; it can be elevated but not protruded. In the lizards it is very variably developed, and affords good taxonomic characters; in the snakes it is always slender, bifid, and protrusible. In both snakes and lizards it is furnished

with numerous sensory corpuscles and is used very largely as an organ of touch. The sense of taste, if it exists at all, is probably very feeble.

Ear.—All reptiles can hear. In the crocodilians an outer ear is present, and in most chelonians and lizards a drum (tympanum) is more or less visible and is in direct continuity with a rod-like structure, the columella auris. In many of the burrowing forms of lizards the tympanum has been covered over and no external ear is visible. Snakes have no external ear openings, nor tympanum, nor tympanic cavity.

Eye.—All reptiles have eyes, but in some burrowing snakes (Typhlopidæ, Leptotyphlopidæ), and in the snake-like lizard *Dibamus*, they are more or less hidden beneath the scales of the head, and their functional power is probably extremely limited. Eye-lids, movable or fixed, are present in all the Oriental lizards; they are absent in all snakes, although they may be detected in a vestigial condition in the embryo.

Smell.—All the living reptiles have some sense of smell.

Secondary Sexual Characters.—Sex dimorphism occurs in most reptiles. This branch of the subject has been greatly neglected both by museum and field workers. The difference may be in coloration, and sometimes is only assumed by the male in the breeding season. In other species definite structural variation is present; but it may be extremely slight, and careful search is needed to discover it.

Order **LORICATA**.

THE CROCODILIA.

Loricata Merrem, Syst. Amphib. 1820, p. 34; Williston, Osteol. Rept. 1925, p. 287.
Emydosauri Gray, Ann. Phil. (2) x, 1825, p. 195.—*Emydosauria*, Boulenger, Fauna Brit. Ind. 1890, p. 1.

Premaxillæ enclosing or nearly enclosing the external nares, which are at the extremity of the snout; maxillary and palatine bones meeting in the mid-line of the palate, the internal nares being carried far back into the mouth. Quadrate bone immovably united to the cranial arches; two horizontal bony temporal arches; teeth separately implanted in alveoli. Acetabulum formed by the ilium and ischium, the pubes excluded and not meeting in a median symphysis; seven or eight series of "abdominal ribs," each composed of two slender rods on each side which together form an angle directed forwards; dorsal ribs, at least the anterior ones, two-headed.

In the structure of the palate and the pelvis the Loricata or Crocodilia differ from all other reptiles. With the exception of the Crocodilidæ all the families included in the order are extinct. Their affinities are with the Dinosaurs, but they cannot be directly derived from them.

The recent species made their first appearance in the Upper Cretaceous of Europe and North America; they flourished during the Tertiary epoch in Europe, Asia, and America, disappearing in Europe at the beginning of the Pleistocene. The Chinese Alligator (*Alligator sinensis*), inhabiting the Yang-tse Kiang, is the only living relic of their former peri-arctic range, the other species being distributed throughout the tropical or warm parts of the earth.

Evolution in the Crocodilia has progressed along two lines—namely, a long and narrow-snouted form and a broad and comparatively short-snouted one. The former is the more primitive. The elongation of the snout is due chiefly to the prolongation forwards of the maxillary bones, and the union of the maxillæ, palatines, and pterygoids in the mid-line of the roof of the mouth to form a secondary bony palate has shifted the opening of the nares right to the back of the mouth.

The upper temporal fossa varies greatly in size in different genera. In the more primitive forms it was as large as, or even larger than, the orbit, and this condition still obtains in the Gharial (*Gavialis*), which is undoubtedly the most primitive of the living crocodilians. In all the other genera

now existing it is distinctly smaller than the orbit, and in some, *Osteolæmus* and *Caiman*, it has become almost obliterated. *Crocodilus cataphractus* and *C. johnstoni* are examples of the long-snouted forms now living, and *Tomistoma schlegeli*, the Malayan or False Gharial, appears more closely allied to these species than to *Gavialis*.

The quadrate bone is large; it extends obliquely backwards and is firmly wedged in, and in the adult is partly fused with, the quadrato-jugal, the squamosal, and the occipital bones. The symphysis between the two halves of the lower jaw is very variable in length, the variation being dependent upon the length of the snout. Thus it is long in the Gharial, short in the Crocodiles.

The vertebral column of the recent Crocodilia consists usually of 9 cervical, 15 dorsal and lumbar, 2 sacral, and from 34 to 40 or more caudal vertebræ. Most of them are procœlous. They are connected together by fibro-cartilaginous pads, except when these are abolished by fusion of the adjoining vertebræ. Lateral movements of the trunk are comparatively limited; the greatest amount is possible at the base of the tail, where the body of the first caudal vertebra is biconvex. The ribs are two-headed—that is to say, they articulate with the vertebræ by two distinct heads; but the position of the heads relative to one another and to the vertebræ is not the same throughout. The ribs of the five or six lumbar vertebræ are stout and in the adult are firmly fused with the vertebræ. Most of the caudal vertebræ have chevron bones. These are more or less Y-shaped outgrowths of the intercentra, projecting downwards from the lower surface of the bone. The sternum remains cartilaginous and is connected with the coracoids and seven or eight pairs of ribs; it then bifurcates, each half carrying another two or three ribs. The so-called "abdominal ribs," which occupy the space between the posterior end of the sternum and the pubis, have nothing to do with the true ribs; they are ossifications of the fibrous tissue which lie between the skin and the muscles. Other reptiles of to-day which possess these structures are the Tuatera of New Zealand (*Sphenodon punctatus*), the most primitive living reptile and some lizards, in particular the Chameleons and the Geckoes.

The composition of the pelvis is unique. It is formed in the adult of three separate bones. The ilium and ischium combine to form the acetabulum for the reception of the head of the thigh-bone, the ilium being also firmly united above with the sacral ribs. The pubis has no share in the acetabulum; it slopes forwards and inwards, is loosely attached to the ischium, and is united with its fellow in the mid-line by cartilage.

The stomach is comparatively small, but is compensated for by an unusually large gullet in which food can be stowed away

whilst digestion in the stomach is proceeding. The stones which are found in the stomachs of the Crocodilia are swallowed as an aid to digestion, just as a bird swallows sand and grit and stocks it in its gizzard.

In the possession of a four-chambered heart, of teeth which are implanted in separate sockets, and of a diaphragm separating the thoracic from the abdominal cavities, the Crocodilia are more highly organized than any other reptiles.

The cloaca is formed as follows :—The coprodæum and urodæum are confluent and form a large oval bag, closed in front and behind by strong sphincters. Normally it acts as a receptacle for urine, and into it also open the oviducts, near the base of the clitoris. The proctodæum or outermost chamber contains the large, unpaired penis. This arises from the ventral wall of the chamber and has a deep longitudinal groove on its dorsal aspect to conduct the seminal fluid. On either side of the root of the penis opens a peritoneal canal. The outer opening of the cloaca is a longitudinal slit, and within it, placed dorso-laterally, are the two anal musk-glands.

All the members of the family are adapted for an aquatic existence. The compressed tail by which they propel themselves through the water can serve also as a weapon of defence and offence. The nostrils are provided with valves and are placed on the upper surface of the snout, but the opening of the choanæ lies far back in the head at the beginning of the throat. By means of a transverse fold on the back of the tongue, which meets a similar fold on the palate, the air passages can be shut off completely from the mouth, and the creature is thus able to breathe while holding its prey in the water. The eye, in addition to an upper and a lower lid, has a nictitating membrane which is drawn across it when the creature is submerged. The pupil is vertical. The outer ear lies in a recess which can be completely closed by a movable flap of skin ; it then appears as a longitudinal slit immediately behind the eye. The tongue is entirely attached to the floor of the mouth, and can be elevated but not protruded.

The integument of the Crocodilia consists of hard horny scales or scutes, between which the skin is soft. Upon the back these scutes are arranged in closely-set, regular, transverse series and are extensively ossified, forming a regular dermal armour. In *Crocodilus* and *Gavialis* they are confined to the dorsal region and a few scattered ossifications upon the outer sides of the limbs. The teeth are shed at intervals throughout life, the successors lying below, with their cusps partly fitting into the roots of the teeth to be expelled. The number of teeth in the premaxillary bone is usually five, but in *Crocodilus porosus* and a few other species the second pair is lost with maturity and is not replaced. In

the genus *Crocodilus* the fourth tooth in the lower jaw fits into a lateral notch in the upper at the junction of the premaxillary and maxillary bones. This simple character serves to distinguish the Crocodiles from the Alligators, and the latter name, as often used in India for these creatures, is a misnomer. With the exception of *Alligator sinensis*, already referred to, the Alligators are inhabitants of America.

All crocodilians possess two pairs of sexual or scent glands, the secretion of which is most active during the breeding season. One pair is situated on the throat, on the inner sides of the right and left halves of the jaw, the openings being visible externally; the other lies within the lips of the cloacal slit.

The age to which the Crocodilia live is unknown. Flower (Proc. Zool. Soc. 1925, p. 937) records two examples of *C. palustris* that were alive in the Zoological Gardens at Trivandrum after 27 and 30 years respectively, but they no doubt live much longer than this. Alligators have survived 40 years in captivity. Growth is comparatively slow. *C. siamensis*, which attains an average length of 3 metres, is about 1 metre long at the end of its third year, and this appears to be the usual rate of growth of crocodilians in nature—that is to say, about 10 to 12 inches a year. Adult length is reached in from 10 to 15 years. *C. porosus*, which attains a much greater length, may be an exception to this. Having attained their full length, they continue to increase very slowly in bulk for many years afterwards. In fact, it is possible that growth in this direction never completely ceases. The increase is general, and is quite as marked in the head as in other parts of the body. They are sexually mature some years before full length is attained. Experiments in the Gardens of the Zoological Society of London by Miss Joan Proctor have shown that artificial light has a marked effect upon their rate of growth.

The Crocodilia are oviparous. Their eggs are oval in shape and have a hard white shell. They are deposited on the banks of water, in holes scooped out and afterwards covered up by the parent. Some species make a sort of nest and remain in the vicinity on guard until the young emerge. The embryo is provided with a large "egg tooth" situated at the tip of the snout, its function being to cut through the shell and help to liberate the creature at the time of birth. As soon as this is accomplished it becomes loose and drops off.

Crocodilians are extremely keen of hearing and are very sharp-sighted. Their voice is something between a loud bark and a bellow; they can also, when angry, emit a loud and deep hissing sound.

All the species are strictly carnivorous. It has been stated

by observers in India that they prefer flesh that is putrid; others have said that large carcases are hidden away beneath overhanging banks or under driftwood until decomposition renders the flesh easier to tear off. How far these statements are true remains to be proved. It is quite certain that small prey is usually devoured as soon as it is caught, although Abercrombie (1922) relates an instance of *Crocodilus palustris* burying fish in the ground, presumably to hide it until decomposition had commenced. It is equally certain that large prey is often devoured as soon as it is captured, the limbs being bitten through to facilitate disposal of the carcase. Considering the non-distensible gape of the Crocodilia, it is remarkable what large objects they can swallow. Pitman (1925) relates the discovery of the entire hind quarters of a dhobie's donkey in the stomach of a Gharial. Shortt (1921) states that from a fully-grown *Crocodilus palustris* he once took a complete corpse; it was in three portions, the head and body complete and the legs separate.

As already stated, the air passage can be completely shut off from the mouth, but the food is not swallowed under water. Sometimes the creature will swim to shore and, partly landing, will swallow its prey there. The more usual practice, and especially with small objects, is to hold the head above water, when a gulp or two is sufficient to dispose of it.

The home of the Crocodilia is in the water. On sunny days they will leave it to bask and sleep in the sun, crawling up on to banks or logs for this purpose. They do not leave the water until the sun is well up, and return to it before the sun has set. When basking they lie in such a position that they can dash back into their element at the first sign of danger. The nights are usually spent in the water. They are certainly more active during the night, but their feeding is by no means confined to the hours of darkness.

Numerous articles have appeared from time to time on the sport of crocodile shooting. The most complete one that I know of is by Shortt (1921). They are usually shot for the sake of their skins, which makes up into first class leather. Only the skin of the flanks and lower parts of the body is of use for this purpose. They are shot whilst basking, but unless killed outright or paralysed by a bullet in the spine, will invariably escape into the water and disappear. To shoot a crocodile in the water is useless, for it will sink and be lost. It is said, however, that when badly wounded and about to die, they invariably seek the land.

Bishop Pallegoix, in his 'Description du Royaume Thai ou Siam,' 1854, describes a singular method employed by the Cambodians to kill crocodiles. It is unique and is best given in his own words: "au bout d'un long bambon est un croc

acéré qu'ils trâinent à la suite de leur barque et qu'ils font mouvoir de manière à pouvoir accrocher l'animal quelque part. Pendant qu'il se débat, on passe un nœud coulant à sa queue, dont on coup l'extrémité, alors on enfonce un long rotin dans la moelle des vertèbres ; à mesure qu'il enfonce, le crocodile perd la force, et à peine le rotin est-il parvenu à la moelle de la tête, que l'animal expire."

Family CROCODILIDÆ.

Crocodilidæ Gray, Ann. Phil. (2) x, 1825, p. 195 ; Boulenger, Fauna Brit. Ind. 1890, p. 2 ; Gadow, Amphib. & Rept. 1909, p. 454 ; Mook, Bull. Amer. Mus. Nat. Hist. N. York, xliv. 1921, p. 123 ; Müller, Zeitsch. Wiss. Biol. Berlin, Bd. 2, 1924, p. 427.
Gavialidæ Huxley, J. Linn. Soc. iv, 1859, p. 16.

Pterygoid bones meeting in the mid-line of the palate, enclosing the posterior nares ; vertebræ procœlous ; no clavicles ; sternum cartilaginous ; no sclerotic plates in orbits. A dermal, osseous, dorsal armour, and sometimes also a ventral, present. Manus with five digits, pes with four ; only the three inner digits clawed. Anal opening longitudinal. Copulatory organ unpaired.

Distribution. Africa ; Southern Asia ; the East Indian Archipelago and tropical Australian region ; tropical and subtropical America.

By some herpetologists a separate family of *Gavialidæ* is recognized.

The two genera that inhabit the Indian region can be recognized by the following external characters :—

Snout very long and slender, at least three times as long as broad at the base ; 27–29 teeth on each side in the upper jaw	GAVIALIS, p. 37.
Snout not slender, not more than twice as long as broad at the base (in Asiatic species) ; 17–19 teeth on each side in the upper jaw.	CROCODILUS, p. 40.

Genus **GAVIALIS.**

Gavialis Oppel, Ordn. Rept. 1811, p. 19 (type *Crocodilus gangeticus* Cuvier) ; Boulenger, Fauna Brit. Ind. 1890, p. 3.—*Gharialis*, Theobald, Cat. Rept. Brit. Ind. 1876, p. 37.
Rhamphostoma Wagler, Syst. Amphib. 1830, p. 141 (type *C. gangeticus* Cuvier).
Rhamphognathus Vogt, Zool. Brief. ii, 1856, p. 289 (not of Agassiz).

27 to 29 upper and 25 or 26 lower teeth on each side, anterior largest, laterals subequal ; the first, second, and third mandibular teeth fitting into notches in the upper jaw. Snout extremely narrow and elongate, dilated at the end ; nasal bones

comparatively short, widely separated from the premaxillaries; anterior margin of orbital rim strongly produced. Mandibular symphysis extending to the 23rd or 24th tooth, comprising

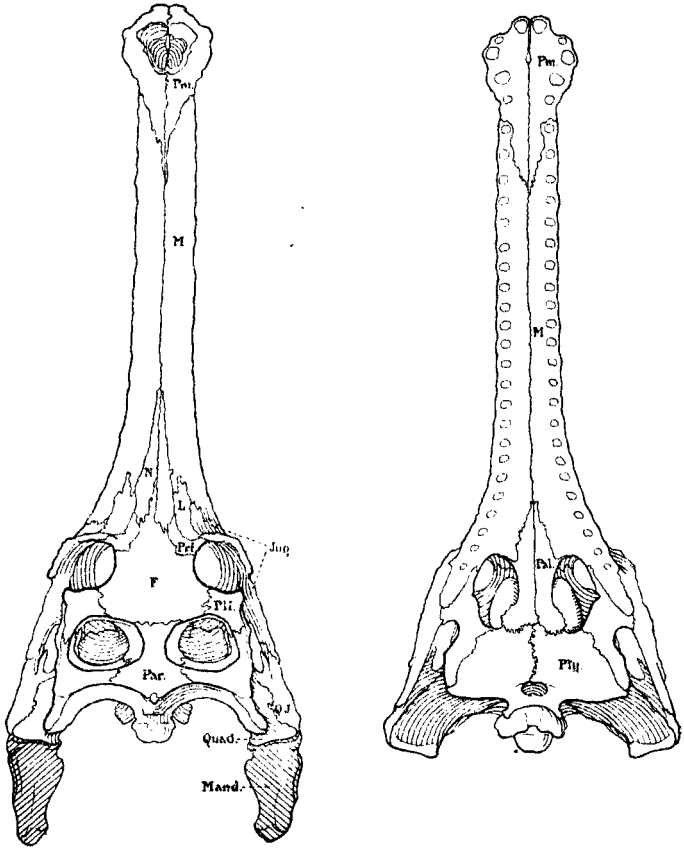


Fig. 2.—Skull of *Gavialis gangeticus*. A. Upper view. B. Lower view.

Pm.	Premaxillary.	*Par.*	Parietal.
M.	Maxillary.	*Jug.*	Jugal.
N.	Nasal.	*Q.J.*	Quadrato-jugal.
L.	Lachrymal.	*Quad.*	Quadrate.
Prf.	Prefrontal.	*Mand.*	Mandible.
Ptf.	Postfrontal.	*Pal.*	Palatine.
F.	Frontal.	*Pty.*	Pterygoid.

the splenial bones. A dorsal shield formed of four longitudinal series of juxtaposed, keeled, bony scutes.

The Gharials are the oldest of the living Crocodilia. The single species now living in India is the sole survivor of a much greater host that once lived there. Fossil forms have been described from the Pliocene deposits of the Siwalik Hills and Narbada valley. *Rhamphosuchus crassidens* is estimated to have attained a length of between 50 and 60 feet (Lydekker, Palæont. Ind. (10) iii, 1876, p. 230).

1. **Gavialis gangeticus**.

Lacerta gangetica Gmelin, Syst. Nat. i, 1789, p. 1057.
Gavialis gangeticus, Gray, Syn. Rept. 1831, p. 56; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 275, and Fauna Brit. Ind. 1890, p. 3; Smoothbore, J. Bombay N. H. Soc. xi, 1897, p. 153; Gadow, Amphib. & Rept. 1909, p. 452, fig. (skull); Annandale, Mem. Ind. Mus. v, 1915, p. 172, and Rec. Ind. Mus. viii, 1912, p. 38; Shortt, J. Bombay N. H. Soc. xxviii, 1921, p. 76, pl. 2; Pitman, idem. xxx, 1925, p. 703; Barton, idem, xxxiii, 1929, p. 450, and M. A. Smith, p. 995; S. S. Flower, Report Zool. Miss. Ind., Cairo, no. 26, 1914, pp. 18–32.
Crocodilus longirostris Schneider, Hist. Amphib. ii, 1801, p. 160.
Crocodilus acutirostris Daudin, Hist. Nat. Rept. ii, 1803, p. 393.
Crocodilus tenuirostris Cuvier, Ann. Mus. Nat. Hist. Paris, x, 1807, p. 66.

Snout from $3\frac{1}{3}$ (in the adult) to $5\frac{1}{2}$ (in the young) times as long as broad at the base. Nuchal and dorsal scutes forming a continuous series, in 21 or 22 transverse rows; an outer row of smaller less regularly placed scutes sometimes present; two small post-occipital scutes. Median fingers one-third, outer toes two-thirds webbed. A strong serrated fringe along the outer sides of the limbs. The adult male develops a large, hollow, cartilaginous protuberance on the end of its snout.

Dark olive or brownish above, whitish or yellowish below. Young paler, with dark spots or cross-bands.

Total length up to $6\frac{1}{2}$ metres. Pitman records a specimen shot at Fyzabad which measured 21 ft. 6 in. in length. Males are said to grow considerably larger than females; Shortt states that the latter do not exceed 14 feet in length.

Range. The Indus, Ganges, Mahanadi, and Brahmaputra Rivers and their tributaries, and the Kaladan River, Arakan. Barton (1929) records a specimen shot at the mouth of the Maingtha, a tributary of the Sweli River, Upper Burma; it is the sole record from the Irrawaddy River system. Annandale (1915) was "informed on good authority that it occurs in the Chilka Lake," the waters of which are brackish during some part of the year.

The name Gharial—or, as it is sometimes incorrectly written, Gavial—is said to have originated in the resemblance of the protuberance on the male snout to a "ghara" or earthenware pot. Very little has been written about the

creature's habits, and I am indebted for much of the information given here to Mr. G. A. Levett-Yeats, who lived for many years in the United Provinces, where they are common. Gharials are found only in rivers. Their food consists chiefly of fish and sometimes birds, and they have been known to seize goats and dogs. Very occasionally they will attack man, but they are not much feared on this account. The discovery of human ornaments in their stomachs does not necessarily indicate man-eating propensities; they are mostly acquired from corpses. In the winter months and during the hot weather they spend most of the day basking in the sun on sand-banks, with extended jaws, but as the sun goes down they slip into the water. During the rains they are not much in evidence and, owing to the flooded state of the Ganges, many of them migrate, at that time, to smaller streams. The Gharial has the crocodilian habit of floating in the stream with only the eyes and the tip of the snout above water.

Their eggs, 40 or more in number, are deposited in sand-banks. They measure 85–90 mm. in length by 65–70 in breadth. The young, which appear in March and April, are about 375 mm. long.

Genus **CROCODILUS.**

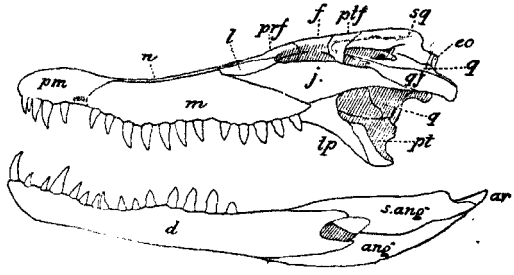
Crocodylus Gronovius, Zoophyl. fasc. i, 1763, p. 10; Laurenti, Syn. Rept. 1768, p. 53 (type *niloticus*).—*Crocodilus*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 277, and Fauna Brit. Ind. 1890, p. 4; M. A. Smith, J. Bombay N. H. Soc. xxxiii, 1929, p. 996.
Champse Merrem, Tent. Syst. Amphib. 1820, p. 36.
Mecistops (in part) Gray, Cat. Tort. Croc. etc. 1844, p. 57 (type *cataphractus*).
Oopholis Gray, t. c. p. 58, and Ann. Mag. Nat. Hist. (3) x, 1862, p. 267 (type *porosus*).
Palinia Gray, t. c. pp. 60 and 272 (type *rhombifer*).
Molinia Gray, t. c. pp. 60 and 272 (type *americanus*).
Bombifrons Gray, Ann. Mag. Nat. Hist. (3) x. 1862, p. 259 (type *C. bombifrons*).
Temsachus Gray, t. c. p. 272 (type *intermedius*).
Philas Gray, Proc. Zool. Soc. London, 1874, p. 177 (type *johnstoni*).

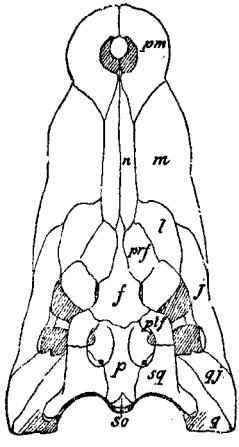
16–19 upper and 14–15 lower teeth on each side; fourth or fifth maxillary tooth largest; fourth mandibular tooth fitting into a notch in the upper jaw. Snout more or less elongate; nasal bones extending to the nasal opening; splenial bones not entering the mandibular symphysis, which does not extend beyond the eighth tooth (fourth or fifth in Asiatic species). A dorsal shield formed of from four to eight longitudinal series of keeled bony scutes.

Distribution. Southern Asia, the Malay Archipelago and tropical Australian region, Africa, tropical America.

About ten species are recognized; three are included in the present work.

A.





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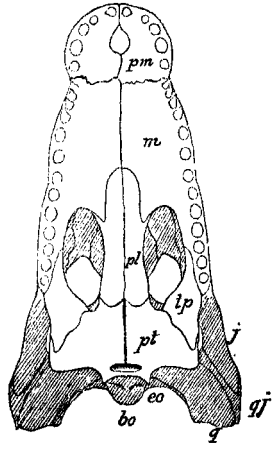

C.

Fig. 3.—Skull of *Crocodilus palustris* (after Boulenger). A. Side view. B. Upper view. C. Lower view.

ang.	Angular.	*pl.*	Palatine.
ar.	Articular.	*pm.*	Premaxillary.
bo.	Basioccipital.	*prf.*	Prefrontal.
d.	Dentary.	*pt.*	Pterygoid.
eo.	Exoccipital.	*ptf.*	Postfrontal.
f.	Frontal.	*q.*	Quadrate.
j.	Jugal.	*qj.*	Quadrato-jugal.
l.	Lachrymal.	*s. ang.*	Supra-angular.
m.	Maxillary.	*so.*	Supraoccipital.
n.	Nasal.	*sq.*	Squamosal.
p.	Parietal.	*tp.*	Transpalatine.

Key to the Species.

Four teeth in each premaxillary bone in the adult; premaxillo-maxillary suture curved backwards or W-shaped: a more or less strong ridge extending forwards in front of each eye.

- Snout $1\frac{2}{3}$ to $2\frac{1}{6}$ times as long as broad at the base; bony portions of the dorsal scutes separated from each other by soft skin; post-occipital scutes usually absent ..... *porosus*, p. 42.
- Snout $1\frac{1}{2}$ to $1\frac{5}{6}$ times as long as broad at the base; bony portions of the dorsal scutes in contact with one another in a transverse series; one or two pairs of post-occipital scutes ..... *siamensis*, p. 44.

Five teeth in each premaxillary bone in the adult; premaxillo-maxillary suture directed more or less straight across the palate; bony portions of the dorsal scutes in contact with one another in a transverse series; snout $1\frac{1}{3}$ to $1\frac{1}{2}$ times as long as broad at the base, without distinct ridges ..... *palustris*, p. 47.

2. Crocodilus porosus.

Crocodilus porosus Schneider, Hist. Amphib. 1801, ii, p. 159; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 284, and Fauna Brit. Ind. 1890, p. 4; Ferguson, J. Bombay N. H. Soc. vi, 1891, p. 116; Smoothbore, idem, xi, 1897, p. 156; Gadow, Amphib. & Rept. 1909, p. 458, fig. (skull); S. S. Flower, Rep. Zool. Miss. Ind., Cairo, no. 26, 1914, p. 18; Barbour, Singapore Nat. no. 4, 1924, p. 88; Mell, Arch. Naturg. Berlin, lxxxviii, 1922, p. 110.

Crocodilus oopholis Schneider, l. c. p. 165.

Crocodilus biporcatus Cuvier, Ann. Mus. Hist. Nat. Paris, x, 1807, p. 48, pls. 1 & 2.

Crocodilus biporcatus raninus Schleg. & Mull. in Temminck's Vert. Nat. Ges. Ned. Ind., Rept. 1844, pp. 26 & 28, pl. 3 (type loc. Borneo).

Oopholis pondicerianus Gray, Ann. Mag. Nat. Hist. (3) x, 1862, p. 268, pl. 7 (type loc. Akyab; Brit. Mus.).

Crocodilus novæ-guineæ Schmidt, Pub. Field Mus. N. H. Chicago, xii, 1928, p. 176, pls. 13 & 14 (type loc. Sepik R., New Guinea; Field Mus., Chicago).

17–19 upper teeth on each side, four in each premaxillary in the adult. Premaxillo-maxillary suture produced posteriorly or W-shaped. Snout $1\frac{2}{3}$ to $2\frac{1}{6}$ times as long as broad at the base, with a more or less strong ridge, nearly half the length of the snout, starting from in front of the eye and converging slightly towards its fellow.

Four large nuchals forming a square, with a smaller one on each side; two small occipitals rarely present. Dorsal scutes well separated from the nuchals, in 16 or 17 transverse and 6 to 8 * longitudinal series, the bony portions of the scutes well

* Only four in the type of *C. pondicerianus*.

separated from one another in the adult; smaller scutes, less regularly placed, outside.

Fingers webbed at the base; web between the outer two toes reaching to the ends of the digits, that between the two middle toes shorter the membrane not reaching to the end of the digit on the outer side, inner toes half webbed. A serrated fringe along the outer sides of the limbs.

Dark olive or brown above, whitish below; young paler, spotted and marked above with black.

Length. A skull from Bengal in the British Museum collection is stated by the donor to have belonged to a specimen that was 33 feet in length, and Barbour (1924) records an example from the Philippine Islands which was 29 feet in length. These appear to be the largest authentic records and are well above the average. Individuals much exceeding 20 feet in length are nowadays extremely rare.

Range. The east coast of India and the southern extremity of the west coast as far north as Cochin; Ceylon; the coasts of Indo-China; the Malay Peninsula and Archipelago; the north coast of Australia; the Solomon and Fiji Islands. Mell (1922) records a specimen obtained in 1912 in southern China (Hongkong district), but it appears now to have been exterminated from that region. There is no record of its occurrence in Tonkin or Annam. It is common in Cambodia and Cochin China at the mouths of the Mekong and Donai Rivers, and this appears to-day to be the limit of its eastern range on the continent of Asia.

The Estuarine Crocodile inhabits the mouths of muddy rivers and canals near the sea. It takes freely to salt water and has been found several miles out at sea; it does not ascend rivers above tidal limits. The deltas of the great rivers where there are large tracts of semi-inundated alluvial country are particularly suited to its habits.

The huge size to which it grows enables it to overcome large and powerful animals, and entitles it to be called the largest of living reptiles. It is the species which is chiefly responsible for the annual loss of human lives in Asia which is attributed to crocodiles. When once they have acquired man-eating habits, they appear, like man-eating tigers, to have a preference for human beings, probably because they find they are more easily obtained than wild beasts. Naturally it is only when adult that they are able to attack man and large animals. Fish enter largely into their dietary; birds are seized suddenly from below as they float on the surface of the water; the hard shell of the chelonian is no protection to it against this voracious creature, and after one or two crunches it is swallowed entire. Mr. S. F. Hopwood, Chief Conservator of Forests, Burma, to whom I am indebted for

much information about this species in Burma, tells me that an 8-foot individual shot by him in the delta of the Irrawaddy had its stomach full of crabs. Certainly crustaceans and insects enter largely into their dietary when young.

The female makes a sort of nest with rushes or reeds or dead leaves, the heat from the fermentation of which no doubt assists in the incubation of her eggs. She is said to remain in the vicinity until the young are hatched, possibly to assist them to the water when they emerge from the shell (see p. 46). The Burmans believe that she keeps the nest damp by splashing water over it with her tail. Moisture is essential for incubation; if the eggs become dry the young perish. Kopstein (1930) records two nests from Java; they contained between 50 and 60 eggs each. The eggs were about 85×55 mm. in size.

The Burmans and the Karens of the Irrawaddy delta are fond of the flesh of this crocodile. The most usual method of catching them is to bait a small raft with a duck or a puppy and hang large hooks on either side. These hooks are attached to a rope, and, to prevent the crocodile from biting through it, the end of the rope is frayed into numerous threads, to each of which a small hook is tied. The threads get between the creature's teeth and cannot then be bitten through. The rope is attached to a large bamboo, and upon this the crocodile "plays" himself until he is tired, when he is hauled out of the water and killed. The natives of Siam catch it in much the same way. A duck is generally used as a bait, but is allowed to swim in the water, so tethered that it cannot move more than a short distance. The Siamese do not eat the flesh of the Estuarine Crocodile, but its gall-bladder is believed to have wonderful medicinal powers and commands a high market price. It is used by women in cases of sterility. The Karens spear these crocodiles as they lie on the banks in the moonlight. The head of the spear is detachable and has a light line attached to it, which is attached in its turn to a strong bamboo pole.

Crocodilus novæ-guineæ Schmidt, based on two skulls, is placed in the synonymy of this species; the description and figures agree in every way with skulls of undoubted *porosus* from Siam in my own collection.

3. Crocodilus siamensis.

Crocodilus siamensis Schneider, Hist. Amphib. ii, 1801, p. 157 (type loc. Siam; based on drawings in Mem. Acad. Sc. Paris, iii, 1666–1669); Günther, Rept. Brit. Ind. 1864, p. 61, pl. 7, fig. B; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 282; M. A. Smith, J. Nat. Hist. Soc. Siam, iii, 1919, p. 217, 3 pls., and Bull. Raffles Mus. no. 3, 1930, p. 1; Müller, Palæont. Hung. 1923, p. 109, figs. (skull).

Bombifrons siamensis, Gray, Cat. Sh. Rept. ii, 1872, p. 13.

Crocodilus galeatus Cuvier, Ann. Mus. Hist. Nat. Paris, x, 1807, p. 51, pl. 1, fig. 9; Dum. & Bib., Hist. Rept. iii, 1836, p. 113.
Crocodilus palustris Laidlaw, Proc. Zool. Soc. 1901, p. 581 (Patani).
Crocodilus ossifragus Dubois, Tidschr. Kon. Neder. Aardrijksh, xxv, 1908 (Pleistocene of Java); Müller, Palæont. Hung. 1923, p. 2.

17 or 18 upper teeth on each side, four in each premaxillary in the adult. Premaxillo-maxillary suture on the palate produced posteriorly. Snout $1\frac{1}{2}$ to $1\frac{5}{8}$ times as long as broad at the base, with a more or less strong ridge, one-quarter the length of the snout, starting from the eye and converging slightly towards its fellow of the opposite side; a feebly developed interorbital ridge usually present.

Four large nuchals forming a square and usually another one on each side; one or two pairs of post-occipital scutes in a transverse series. Dorsal scutes well separated from the nuchal, in 16 or 17 transverse and 6 longitudinal series, the bony portions of the scutes in contact with one another in transverse series; smaller scutes, less regularly placed, outside. Fingers webbed at the base: toes as in *porosus*, but the web more emarginate. A serrated fringe along the outer sides of the limbs.

Dark olive or brownish above, whitish or yellowish below. Young paler, spotted and marked above with black.

Total length $3\frac{1}{2}$ metres.

Range. Siam and French Indo-China as far north as lat. 16°; the northern part of the Malay Peninsula; Java.

Still fairly common in the country near Nakon Sawan (Central Siam), although numbers have been shot of recent years; also in the Quaa Noi River, Sai Yoke district, near the Burmese frontier, and at the northern end of the Inland Sea, Peninsular Siam. The Skeat Expedition obtained a specimen at Biserat, Jalor, Patani; it is now in the British Museum. The only record from French Indo-China is a skull in my collection from Kemarat (lat. 16°) on the Mekong River, but it is said to be common in swamps in southern Cambodia. The crocodile which is reported to be plentiful in a small lake at Tat-Lak (altitude 1000 metres) on the Langbian Plateau, S. Annam, is probably referable to this species. It appears to be rare in Java.

The Siamese Crocodile inhabits rivers and freshwater swamps, preferably the latter where the water is still. In the rivers it is usually found above tidal limits. It feeds chiefly upon fish and is not as a rule aggressive to human beings. I have never heard of any grown person being attacked by it, but small children are said to be sometimes seized. The country people have little fear of it and do not hesitate to bathe in the water known to be inhabited by it; they say that as long as there are plenty of fish to eat, it will not attack

man. Its flesh is sometimes eaten by them, but it is not now a regular article of commerce as it appears to have been in the middle of the last century. It is probably this species that Bishop Pallegoix refers to when he relates * that one day on visiting the Christian Annamite village † he saw more than 50 crocodiles, large and small, tethered to the piles on which the houses were built. The flesh was sold in the same way as pork, but it was much cheaper. In his vivid style he also tells of the fearless way in which in those days they caught these creatures: "Ils épient le moment où cet animal dort sur le rivage, lui sautent sur le dos, les fourrent les doigts dans les yeux, lui poussent un lien à la gueule, l'attachent par le milieu du corps et le jettent dans leur barque."

The eggs of the Siamese Crocodile are deposited in sand-banks at the beginning of the rainy season. They measure about 75–80 mm. long by 50 broad.

I have kept the young on many occasions and found them very entertaining pets. Most of them came into my possession immediately after birth, when they were about 25 centimetres long. Their teeth at that age were extremely sharp, and they would snap readily when handled, so that they had to be picked up with caution. Their voice was a curious high-pitched croak, and they soon learned to reply to anyone who imitated it, so that quite a conversation could be entered into. They emitted the same croak when picked up or if anyone stamped in their vicinity. I am inclined to believe that this "embryonic voice" has a definite function. Voeltzkow, who has made careful observations upon *C. niloticus* in Madagascar ‡, believes that the mother returns to the nest at the proper time in order to dig the young ones out and conduct them to the water, and she is probably warned of this by the cry which the young emit while still within the unbroken shell. I have never heard the sound produced except by the very young, but I have no note of the exact age at which it is lost. Gadow records the same high-pitched voice in the young of *C. porosus*.

My little crocodiles would never eat by themselves during the first months of their existence, although every variety of food was offered them, and during that time they were forcibly fed. Bits of raw meat and fish formed their chief diet. Sometime during the third month they would begin to feed by themselves. They lived at that time in a large earthenware bath, with shallow water and bricks upon which they could climb up out of it, and upon these they spent most of their time. Later on they were turned out into a pond in the

* 'Description du Royaume Thai ou Siam,' i, 1854, p. 174.

† The Annamite village of the Catholic Mission to-day is situated on the banks of the river just above Bangkok.

‡ SB. Akad. Berlin, 1891, p. 115, and 1893, p. 347.

compound. It had a slope at one end upon which they could crawl out and bask, and was surrounded by a wooden enclosure 30 inches high to prevent their escaping. The daytime was spent in the water or upon the slope, but when they grew bigger they would sometimes leave the pond after dark and wander about in the enclosure. They grew sufficiently tame to come out of the water and feed from the hand, provided that one kept fairly still. Live fish, however, that were put into their pond were never touched as far as I am aware.

4. Crocodilus palustris.

Crocodilus palustris Lesson, in Belang. Voy. Ind. Or., Zool. 1834, p. 305 (type loc. Ganges); Günther, Rept. Brit. Ind. 1864, p. 61, pl. 8; Theobald. J. Linn. Soc., Zool. x, 1868, p. 26; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 285, and Fauna Brit. Ind. 1890, p. 5; Gadow, Amphib. & Rept. 1909, p. 454; Smoothbore, J. Bombay N. H. Soc. xi, 1897, p. 154; Annandale, Rec. Ind. Mus. viii, 1912, p. 38; S. S. Flower, Rep. Zool. Miss. Ind., Cairo, no. 26, 1914, p. 18, pls. 3 & 4; Shortt, J. Bombay N. H. Soc. xxviii, 1921, p. 76, pl. 1; Abercromby, idem, 1922, p. 553; Monteath, idem, xxix, 1923, p. 300.

Crocodilus bombifrons Gray, Cat. Tort. Croc. etc. 1844, p. 59 (type loc. India; Brit. Mus.).

Crocodilus trigonops Gray, Cat. Tort. Croc. etc. 1844, p. 62 (type loc India; Brit. Mus.).

Crocodilus vulgaris var. *indicus* Gray, Syn. Rept. 1831, p. 58 (nom. nud.).—*Bombifrons indicus* Gray, Trans. Zool. Soc. 1869, p. 140. fig. (skull).

19 upper teeth on each side, 5 in each premaxillary in the adult; premaxillo-maxillary suture on the palate directed nearly straight across. Snout $1\frac{1}{3}$ to $1\frac{1}{2}$ times as long as broad at the base, usually without distinct ridges in front of the eye; when present they extend only for a short distance.

Four large nuchals forming a square, with a smaller one on each side; two pairs of post-occipital scutes in a transverse series. Dorsal scutes in 16 or 17 transverse, and 4, sometimes 6, longitudinal series, the bony portions of the scutes in contact with one another in the transverse series; smaller scutes, less regularly placed, outside. Fingers webbed at the base; toes as in *porosus*, but the web more emarginate. A serrated fringe along the outer side of the limbs.

Dark olive or brownish above, whitish or yellowish below. Young paler, with black spots and markings.

Total length 4 metres.

Range. The whole of the Indian Peninsula and Ceylon, extending west as far as the Dasht River, near the Persian frontier, in Baluchistan, north to Nepal and east as far as the Darrang District on the Brahmaputra in Assam. Its existence in Burma at the present time is doubtful. Theobald (1868) recorded a large specimen from Thayetmyo, and remarked that it was the only specimen he had ever seen from that country. There is no record of its having been obtained there since.

The Mugger, or Marsh Crocodile, or Broad-Snouted Crocodile, is the freshwater crocodile of India. It inhabits swamps, tanks, and rivers, usually, if not always, above the limits of salt water. When its habitat dries up, as may happen at the end of the dry season, it buries itself in the mud and æstivates, or it may wander off in search of water elsewhere. It feeds chiefly upon fish and birds and only occasionally attacks man.

The eggs, 20 or more in number, are deposited at the beginning of the rainy season in holes scooped out in sand-banks. Incubation is said to take about 40 days, but the time varies considerably with the temperature. The young when born are about 250 mm. in length.

In certain places in India the Mugger is kept in a state of semi-captivity. The one which has been most often written about is the famous "Mugger Pir," situated in the sandy desert of Sind about ten miles from Karachi. It is connected with the tomb of Hadji Mangho, a holy hermit who is said to have settled there in the 13th century. The first European to give an account of this place was Lieut. Carless, of the Indian Navy, who visited it in 1838. It was then a large swamp and contained many hundreds of crocodiles. Now it is a comparatively small tank surrounded by a high wall. Major Stanley Flower, who visited the spot in 1913, counted 24 more or less adult crocodiles and three young ones. He was told there were many more young ones in the tank. The creatures breed there, laying their eggs in a sandy corner of the enclosure. The Mugger is hunted by the natives of Sind, but only as a defensive measure in order to protect their fish. Taking advantage of the creature's natural timidity, and armed with nothing more formidable than poles, nets, and ropes, they locate it where it lies hiding in the mud on the bed of the stream, entangle it in their nets, and finally rope it and bring it to land, where it is despatched (Monteath, 1923). Another method is simply to rope it as it rests beneath an overhanging bank or a fallen tree-trunk. It is said that if the operation is done slowly and quietly the creature offers no resistance.

Order **TESTUDINES.**

CHELONIANS (TORTOISES, TERRAPINS, AND TURTLES).

Testudines Batsch, Anleit. Kennt. Thiere, Mineral. i, 1788, p. 437.
Chelonia Macartney, in Ross, Transl. Cuvier's List Comp. Anat. i, 1802, tab. iii; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 4, and Fauna Brit. Ind. 1890, p. 6.
Testudinata Oppel, Ordn. Rept. 1811, p. 3; Bell, Monogr. Test. 1836–42; Stejneger, Herpet. Japan, 1907, p. 483, with further synonymy; Siebenrock, Zool. Jahrb. Syst. Jena, Suppl. 10, 1909, p. 432.

Body encased in a bony shell; ribs single-headed, the anterior attached between two vertebræ; quadrate bone immovably united to the cranial arches; jaws toothless, covered with horny cutting sheaths. Shoulder-girdle internal to the ribs, composed of a forked scapula and a single coracoid, not connected with the clavicles and interclavicle, which are incorporated in the plastron; no sternum. Limbs pentadactyle, phalangeal formula reduced. Copulatory organ unpaired.

Testudines is the oldest name available for this group. It was rejected by Stejneger and *Testudinata* chosen in place of it, on the grounds that it conflicted with the generic name *Testudo* (Herpet. Japan, 1907, p. 49).

The origin of the *Testudines* is unknown. They must have occurred in the Permian epoch, for they are found in the Triassic much as we see them now. Their greatest development was towards the end of the Mesozoic and in the early Tertiary Period. They are now comparatively reduced in the number of families and genera, but the main divisions which occurred in earlier times are still in existence to-day. About 250 species are known.

Their characteristic feature is the exoskeleton or shell, and a study of this is essential for the correct identification of the species. With the exception of the Leathery Turtle (*Dermochelys coriacea*), which has characters that separate it from all other Chelonians, and which is discussed by itself, the shell is constituted as follows (*cf.* fig. 4):—

It is composed of a dorsal portion, the carapace, and a ventral one, the plastron. The former consists of a median series of plates, a right and a left lateral series of costal plates, and usually a series of marginals which surround the whole. The median series is formed by a large nuchal plate which is situated above, but is not attached to, the first dorsal vertebra, of (usually) eight neural plates which are firmly united with the eight dorsal vertebræ below them, and of one to three

supracaudal plates. The costal plates are also usually eight in number on each side. They are firmly united with the ribs below them, and by their inner and outer extremities with the neural and marginal plates respectively. The marginal bones are usually eleven on each side, in addition to the azygous post-marginal, except in the *Trionychidæ*, in which they are absent or vestigial.

The plastron consists of nine bones in Asiatic species, namely a pair of epi-, hyo-, hypo- and xiphiplastral plates and a median entoplastral plate. The last-named may be regarded as the homologue of the interclavicle, the epiplastra as the clavicles, while the remaining elements are modifications of the "abdominal ribs" such as are seen in the Crocodilia. The extent to which these plates are developed varies greatly in different groups. In the young the several plates are separated by large spaces (fontanelles). In the marine and freshwater turtles (*Cheloniidæ* and *Trionychidæ*) they are never filled up, the bones remaining as more or less separate elements throughout life, but in most groups they become entirely filled up, and in the *Testudinidæ* and *Emydidæ* especially, the plastron forms one continuous mass. Laterally the hyo- and hypoplastral bones are extended and unite, either by suture or by ligamentous tissue, with the carapace. This extension is called the bridge. In those species which have a bony union the hyo- and hypoplastral bones each send up a process inside the shell, respectively termed the axillary and inguinal buttresses, which ankylose with the marginals and with the costal plates. In the Indian genera *Batagur*, *Kachuga*, and *Hardella* these buttresses are greatly developed, reaching nearly to the vertebræ, and form two lateral chambers occupied by the lungs, which are particularly developed in connection with their aquatic habits.

Externally the shell is covered, except in the freshwater turtles (*Trionychoidea*), with horny epidermal shields, and these do not correspond, either in position or numbers, with the underlying bony plates. On the carapace there are usually five vertebral, four pairs of costal, and twelve pairs of marginal shields. In front of the first vertebral lies the nuchal shield, always small, variable in size and sometimes absent; posteriorly the last pair of marginal shields may be united to form an unpaired pygal. On the plastron there are 12 or more shields, namely, paired gulars, humerals, pectorals, abdominals, femorals, and anals, and in some an intergular, paired or unpaired. Some families (*Platysternidæ*, *Cheloniidæ*) have also a series of inframarginals intercalated between the plastral and marginal shields; in the *Testudinidæ* and *Emydidæ* these shields have been reduced in number and are restricted to the anterior and posterior margins of the bridge, the so-called

[*To face p.* 50.

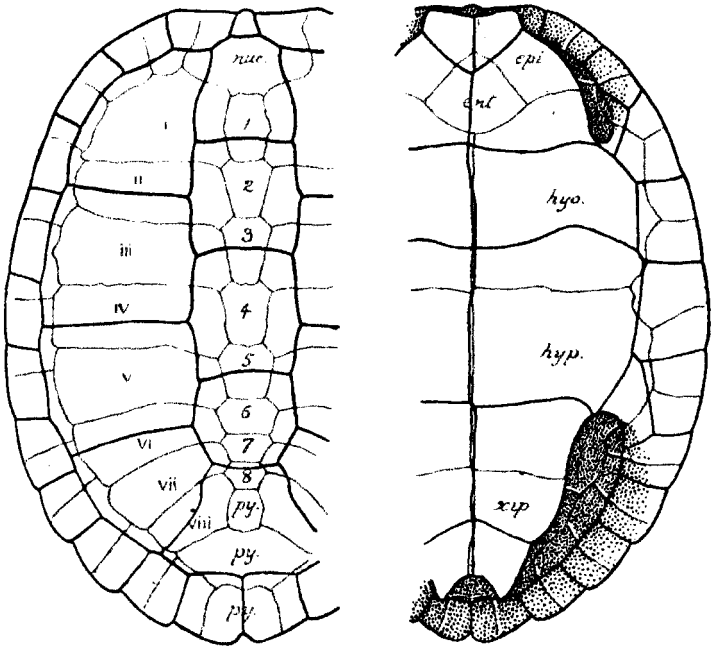

Fig. 4.—Shell of *Hardella thurgi.*

The red lines indicate the bony plates, the black the horny epidermal shields.

nuc.	Nuchal.	*epi.*	Epiplastron.
1–8.	Neural plates.	*hyo.*	Hyoplastron.
py.	Pygal.	*hyp.*	Hypoplastron.
i–viii.	Costal plates.	*xip.*	Xiphiplastron.
		ent.	Entoplastron.

axillary and inguinal shields, usually small and variable in size. In the *Trionychoidea* the horny shell is covered with soft leathery skin instead of horny shields.

It should be remembered that the component parts of the shell—namely, the neural, costal, and plastral plates—are not expansions of the endoskeletal elements. They arise independently as dermal ossifications, and fuse at an early age with the vertebræ, ribs, and plastral bones. In those groups in which there is extensive ossification of the shell (*Testudinidæ*, *Emydidæ*) this fusion is very complete, but in others in which it is not so perfect (*Cheloniidæ*, *Trionychidæ*) the independent origin of the bones is more evident. In *Lissemys* in particular the distal extremities of the ribs and the margins of the neural plate never unite with the overlying bone.

It is a common belief that the age of a tortoise can be told by the number of concentric rings upon its shields. This is only partly true. The original shield with which the creature is born persists throughout life and can often be recognized as such. It is known as the areola. It grows by the deposition of new horn from below, as well as at the periphery, each year's increase being marked by a new ring. With species that live in temperate climates and have their growth annually arrested by hibernation, this can easily be checked; but tropical species that do not hibernate must have their periods of growth also, for in many of them the rings are equally well marked. Their definition, in fact, appears to depend more upon the creature's habitat than upon the climate it lives in, and they are for this reason seen more easily in some genera than in others. The typical land species (*Testudo*) and those semi-aquatic forms that most nearly approach them in character (*Geoemyda*) show it best, the almost purely aquatic species (*Batagur*) and some of *Kachuga*, the least. The growth of the shield varies in different species. In some it proceeds equally all round the margin so that the areola remains central: in others it is greatest along the outer and anterior margins, and the areola becomes correspondingly eccentric. As adult age is reached and growth diminishes, the rings become progressively more irregular and crowded together, whilst the periodical peeling off of the outer layers of the shield renders the rings first formed more difficult to distinguish. Except in the early years of its life it is impossible to reckon the age of a tortoise with certainty.

In concluding the description of the shell, one may draw attention to the enormous changes which this structure has produced in the general organization of the creature. The supporting function of the vertebral column, owing to its solid union with the carapace, has been rendered largely unnecessary, and the muscles usually attached to it have either been lost or

profoundly modified. The shoulder-girdle has come to lie within the ribs instead of outside them, and the humerus therefore, to extricate itself from the shell, has to lie in a horizontal plane with the fore-arm almost at right angles to it, a most disadvantageous disposal of power. The lungs are encased between the carapace and plastron, and are limited still further in their movements by being attached by their dorsal surface to the inner lining of the shell. Expansion by the usual methods is thus impossible. It is replaced partly by the protrusion and retraction of the neck and limbs, partly by the muscular action of the throat, the air being swallowed or pumped into the lungs. Additional respiratory mechanisms in some aquatic tortoises are provided by a pair of highly

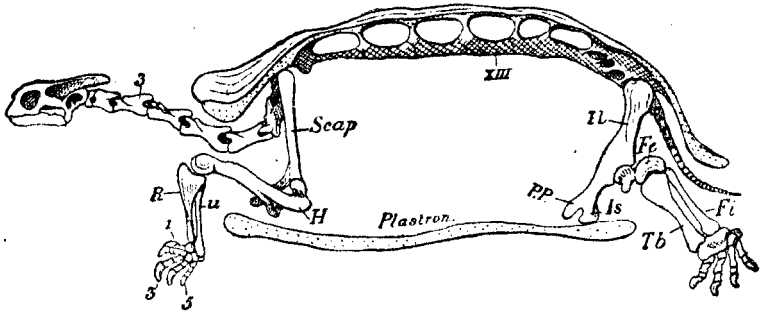

Fig. 5.—Diagram of skeleton of *Testudo*. (After Gadow. By kind permission of Messrs. Macmillan.)

Fe. Femur, foreshortened.
Fi. Fibula.
H. Humerus.
Il. Ilium.
Is. Ischium.
P.P. Pubis.
R. Radius.
Scap. Scapula.
Tb. Tibia.
U. Ulna.
3. Third cervical vertebra.
1, 3, 5. First, third, and fifth fingers.
xiii. Thirteenth (fifth thoracic) vertebra.

vascularized sacs near the vent and by vascularized recesses in the region of the pharynx. Most Chelonians, however, are able to remain for a very long time without breathing. The head and neck can be hidden or retracted within the shell in two ways, either by bending the neck sideways, as in the Pleurodira, or by bending it in an S-shaped curve in a vertical plane (Cryptodira). In the Marine Turtles the neck is cryptodirous, but is only very slightly retractile.

The vertebral column of the Chelonians consists of 8 cervical, 10 dorsal, 2 sacral, and from 16 to 35 caudal vertebræ. Only

the neck and tail are flexible. The cervical vertebræ show remarkable diversity in their modes of articulating with one another ; in no other order of reptiles is the variation so great. The comparative length of the tail is no indication of the number of vertebræ ; in some species it varies in accordance with their age, being longer in the young than in the adult.

The skull in all the Asiatic Chelonians is comparatively convex above, except in the two Mud Turtles *Chitra indica* and *Pelochelys bibroni*, in which it is markedly flattened. The orbits in all the Mud Turtles are placed distinctly towards the upper surface of the head ; in all the other groups they are more or less lateral. The orbit is normally encircled by five bones, namely the maxillary, prefrontal, frontal, postorbital *, and jugal. In *Platysternum* it is excluded, and in *Damonia* also it is sometimes excluded. The varying breadth of the alveolar surfaces of the jaws is not correlated with the feeding habits of the species. It may be broad or narrow in both carnivorous and herbivorous species, e. g., *Damonia* and *Hieremys*.

The greatest variation in the skull is shown in the temporal region. In all the primitive forms it was completely or nearly completely roofed over, and still is in the Marine Turtles (*Sphargidæ*, *Cheloniidæ*) and in *Platysternum*. In most Asiatic species it has become more or less exposed by emargination from behind until only a bar behind the eye (the postorbital arch) and another between the orbit and the tympanic cavity (the temporal arch) remain.

In *Geoemyda*, *Hieremys*, *Cuora*, and *Notochelys*, however, emargination has gone further, and the temporal arch has more or less disappeared. In *Geoemyda* the arch can be studied in all stages of dissolution, a point which will be discussed further when dealing with that genus.

The limbs are modified in accordance with the habits of the species. They are more or less cylindrical in the entirely terrestrial ones, flattened in the semi-aquatic forms, paddle-shaped in the Marine Turtles. In all, however, they are typically pentadactyle and complete.

The sense of hearing of tortoises is apparently not very acute, but the sense of smell is well developed and they have a fine sense of touch. The tongue is broad and soft, but cannot be protruded.

All Chelonians lay eggs. In the Marine Turtles they are spherical in shape and covered with a parchment-like skin ; in the other groups they have a white calcareous shell, and may be spherical or more or less elongate ; they vary considerably in size, even those laid in the same batch.

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* The postfrontal of Boulenger.

Most Chelonians possess scent-glands, but very little is known about them. German anatomists have given the subject some attention, and Bronn in 1890 * published a brief account of what was then known about them. My own observations have enabled me to confirm, to correct, and to amplify his remarks, and the results, as regards the Asiatic species, are incorporated in this work. Both sexes possess the glands. The function of the secretion is presumably that of attraction, by leaving a trail of scent in the waters they inhabit; the disappearance of the glands, therefore, in the typical land species (*Testudinidæ*) is not unnatural. Whether the secretion is cyclical in amount or intensity is unknown. It is more odoriferous in some species (the American Musk Turtles) than in others; in none of the Asiatic species, so far as I am aware, except in *Geoemyda trijuga*, is it strong enough to excite comment. The glands themselves are small and not unlike fat-bodies to look at, and the ducts through which they discharge their contents are very fine, and pursue a somewhat tortuous course before they finally emerge on the surface of the body, usually by piercing the bone. The openings may be round or slit-shaped; they are usually minute, and may be so small that only the most diligent search with a lens will reveal them.

The glands may be axillary, inguinal, or humeral. The two first-named open either in the axillary and inguinal shields themselves, or in the soft skin adjacent to them, or in the sutures between them and the adjacent marginal shields; the humeral glands open on the margin of the carapace above the fore-limb. A more detailed account of the number and position of the glands in the different groups is given under family characters †.

The external sexual characters of the *Testudines* have not received much attention. The concavity of the plastron of the male is in some species sufficient to distinguish it from the female, but in most the tail is a better guide, being longer and with the opening of the vent further back in the male than in the female. The male of *Batagur baska* is said to assume special colours during the breeding-season. Sexual dimorphism in colour, especially during the breeding-season, probably occurs more often than is generally supposed.

The cloaca is large and its divisions are imperfectly defined. The proctodæum contains the unpaired copulatory organ, which is deeply grooved on its dorsal surface and is constructed much like that of the Crocodilia. The coprodæum and urodæum are confluent, and into them open the genital

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* Klass. Ord. Thierreichs, vi, Abt. 3, pt. 1, p. 8.

† The following species described in this work have not, for want of spirit-specimens, been examined:—*Testudo impressa, Kachuga lineata, K. trivittata, Trionyx gangeticus, T. nigricans.*

ducts, the bladder and the end of the gut, the termination of the latter being very marked. Some water tortoises possess also anal sacs, which are diverticula of the urodæum. Their function is to act as auxiliary organs of respiration, which they do by being constantly filled with water through the vent. The fluid which a water tortoise will suddenly squirt out when taken in the hand comes from these sacs and not from the bladder.

The longevity of Chelonians is proverbial. There is no doubt that some of the giant Tortoises have lived for at least 150 years, but Flower has recently cast doubts on the stories that they survive for 200 or 300 years. Nothing is known of the age to which the Indian species live, for the few that have been kept in captivity have not survived long. There are authentic records that *Emys orbicularis*, the Common European Pond Tortoise, has lived for 70 years, and *Testudo græca*, the Mediterranean Land Tortoise, for over 100 years (Flower, Proc. Zool. Soc. 1925).

Most of the Oriental Tortoises are eaten by the country people.

The classification adopted in this work is a modification of that used by Boulenger in his 'Catalogue of Chelonians,' 1889, and by Siebenrock in his 'Synopsis der rezenten Schildkröten,' 1909. The following table shows the general scheme of classification adopted and the distribution of all the families :—

- Testudines
  - Athecæ ..... Sphargidæ (cosmopolitan).
  - Thecophora
    - Pleurodira ... Pelomedusidæ (Africa, S. America). / Chelyidæ (Australia, S. America).
    - Carettoidea .. Cheloniidæ (cosmopolitan).
    - Cryptodira ... Chelydridæ (N. America, New Guinea). / Cinosternidæ (N. & C. America). / Dermatemyidæ (C. America). / Platysternidæ (Indo-Chinese Region). / Emydidæ (Cosmopolitan, except Australia). / Testudinidæ (Cosmopolitan, except Australia).
    - Trionychoidea — Carettochelyidæ (New Guinea). / Trionychidæ (Asia, Africa, N. America).

The following points should be remembered with regard to the measurements of specimens :—

The carapace is measured in a straight line, not over the curve.

The tail is measured from where it leaves the body, but as this point cannot be determined exactly, the length is given in approximate terms. It differs in length also in the sexes. When not more than one-quarter the length of the plastron, the term "short" or "very short" is used; up to one-half the length, "moderate"; more than half the length, "long" or "very long."

The Tortoises and Turtles of the Indian and Indo-Chinese Subregions fall into six families, which may be recognized by the following external characters :—

I. Limbs paddle-shaped, clawless; shell covered with smooth skin; carapace with seven prominent longitudinal keels ..... **Sphargidæ**, p. 57.

II. Limbs paddle-shaped, with one or two claws; shell covered with horny shields ..... **Cheloniidæ**, p. 62.

III. Limbs not paddle-shaped, digits distinct, with four or five claws; shell covered with horny shields.

a. Plastral shields separated from the marginals by infra-marginals; tail as long as the shell ..... **Platysternidæ**, p. 72.

b. Plastral shields in contact with the marginals; tail not as long as the shell.

Limbs more or less flattened; digits webbed; top of head covered with smooth skin or with the posterior part of it divided into shields ..... **Emydidæ**, p. 75.

Limbs more or less cylindrical, the hind ones club-shaped; digits not webbed; head shielded above..... **Testudinidæ**, p. 136.

IV. Digits distinct, claws three; shell covered with smooth skin ..... **Trionychidæ**, p. 147.

Suborder ATHECÆ.

Athecæ Cope, Proc. Amer. Assoc. Adv. Sc. xix, 1871, p. 235; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 7, and Fauna Brit. Ind. 1890, p. 50; Hay, Proc. U.S. Nat. Mus. vol. lxxiii, (3) 1928, p. 6.

Cheloniidea (in part) Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 544.

Bony shell or exoskeleton composed of small plates, not connected with the vertebræ or ribs.

A single family, genus and species, the Leathery Turtle or Luth.

Family SPHARGIDÆ.

Spharyidæ Gray, Ann. Philos. x, 1825, p. 212; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 7; Gadow, Amphib. & Rept. 1909, p. 334.
Dermochelyidæ, Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 551.

The exoskeleton or bony shell of the Leathery Turtle consists of a dorsal portion composed of a mosaic of many hundreds of small polygonal plates of irregular size, the largest of which form seven regular longitudinal ridges converging posteriorly and corresponding to the dorsal keels of the living creature; posteriorly it is extended into a pointed supracaudal portion, and laterally it terminates in an irregular margin just external to the outermost dorsal keel. The ventral portion has no mosaic of plates, but consists of five longitudinal incomplete series of small bones firmly embedded in a dense layer of tissue and corresponding in position with the five ventral keels of the young; the median row is split at the insertion of the umbilical cord. The whole is covered in the adult with smooth skin. Beneath the dorsal shield and resting upon the last cervical vertebra is a flat butterfly-shaped plate of bone, the nuchal plate; it is the homologue of the nuchal of other Chelonians. Beneath the ventral ossicles lie the plastral elements, an annulus of slender bones, eight in number, namely the epi-, hyo-, hypo-, and xiphiplastra; the entoplastron is absent.

The temporal region of the skull is completely roofed over, and in this respect *Dermochelys* resembles the Marine Turtles. It differs from other Chelonians in the absence of the column-like process descending to and articulating with the pterygoid. The neck is short and only slightly retractile. The limbs are paddle-shaped and clawless, the digits of the fore-limb much elongated; the phalanges are without condyles. In the newly-born, vestiges of one or two claws on the fore-limb may be found.

The affinities of *Dermochelys* are still debated. Some regard it as the most highly specialized of the Marine Turtles, others consider it the most primitive Chelonian, and because of its unique shell separate it from all the others. Whichever view is adopted, however, it is sufficiently removed by its structural characters to be placed quite by itself. Siebenrock's attitude (1909) in grouping it with the *Cheloniidæ* has nothing to commend it. Until more palæontological evidence upon the origin of the Chelonians is forthcoming the question must remain unanswered.

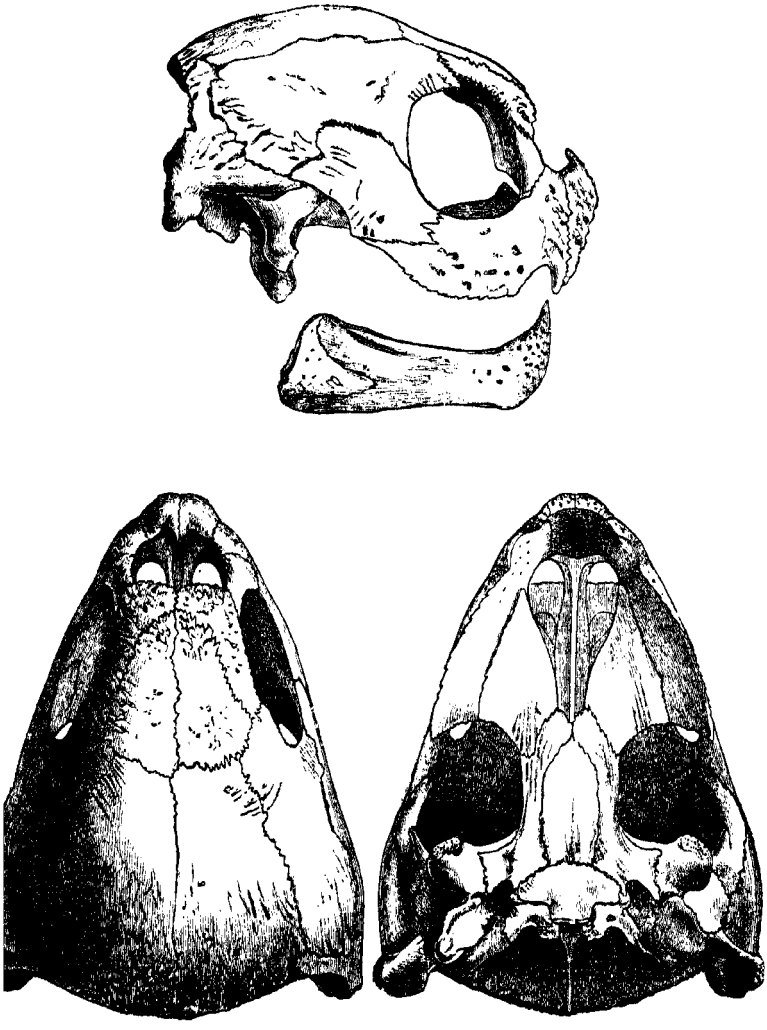

Fig. 6.—Skull of *Dermochelys coriacea*. (After Boulenger.)

Genus **DERMOCHELYS.**

Dermochelys Blainville, Bull. Soc. Philom. 1816, p. 119 (type *Testudo coriacea*).
Sphargis Merrem, Syst. Amphib. 1820, p. 19 (same type).
Coriudo Fleming, Phil. Zool. ii, 1822, p. 271 (same type).
Scytina Wagler, Isis, 1828, p. 861 (subst. name for *Sphargis*).
Dermatochelys Wagler, Syst. Amphib. 1830, p. 133.
Chelyra Rafinesque, Atlantic Journ. i, 1832, p. 64 (type *T. coriacea*).

1. Dermochelys coriacea.

Testudo coriacea Linn., Syst. Nat. ed. 12, 1766, p. 350.—*Dermatochelys coriacea*, Günther, Rept. Brit. Ind. 1864, p. 55.—*Dermochelys coriacea*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 10, and Fauna Brit Ind. 1890, p. 50; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 553; Burne, Proc. Zool. Soc. 1905, p. 291 (anatomy); Kloss, J. St. Br. R. Asiat. Soc. 1907, pls. i–iii; Cameron, J. Bombay N. H. Soc. xxix, 1923, p. 299; Deraniyagala, Proc. Zool. Soc. London, 1930, pt. 3, and Ceylon J. Sc., Sect. B, xvi, 1930, p. 45, pls. 7–9.—*Sphargis coriacea*, Tickell, J. Asiat. Soc. Bengal, xxxi, 1863, p. 367, col. pl.
Sphargis mercurialis Merrem, Syst. Amphib. 1820, p. 19.
Sphargis tuberculata Gravenhorst, Delic. Mus. Vratisl. 1829, p. 9.
Dermatochelys porcata Wagler, Syst. Amphib. 1830, pl. i.
Sphargis angusta Philippi, An. Univ. Chile, civ, 1899, p. 730, 1 pl.
Sphargis coriacea var. *schlegelii* Garman, Bull. U.S. Nat. Mus. 1884, p. 303.

In the newly-born the body and limbs are covered with small irregularly polygonal shields, largest upon the carapace and plastron, the seven dorsal and five ventral longitudinal keels being represented by rows of enlarged squarish raised shields; the top and sides of the head have symmetrical plates. In the adult all these have disappeared and are replaced by smooth skin. The dorsal keels persist as prominent, more or less nodular ridges, but the ventral ones are almost or quite obliterated. The jaws have no enlarged alveolar surface, the margins being simply sharp-edged. The upper jaw has two large triangular cusps between three deep notches, the median of which receives the strong hook of the lower jaw. The fore-limb is as long as the dorsal shield in the young, comparatively shorter in the adult. The tail is short.

The colour of the adult is dark brown or blackish above, spotted or blotched with pale yellow or white: paler below. The young are blackish above, with the longitudinal keels upon the body and the borders of the limbs yellowish or white; below they are white with black markings.

The Leathery Turtle or Luth is the largest of all the Chelonians, attaining a total length of more than two metres and an estimated weight of nearly 1000 pounds.

It is generally distributed in the tropics, but appears to be scarce everywhere, except on the coasts of Ceylon (Deraniyagala). It is only an accidental visitor to temperate regions.

Cameron (1923), writing of it on the coast of Travancore, states that the fishermen informed him that up to 25 years ago it was quite common there, and that some 40 odd would be caught annually, either attempting to come ashore or in specially prepared nets out at sea. During the last ten years or so only two or three have been caught annually. They

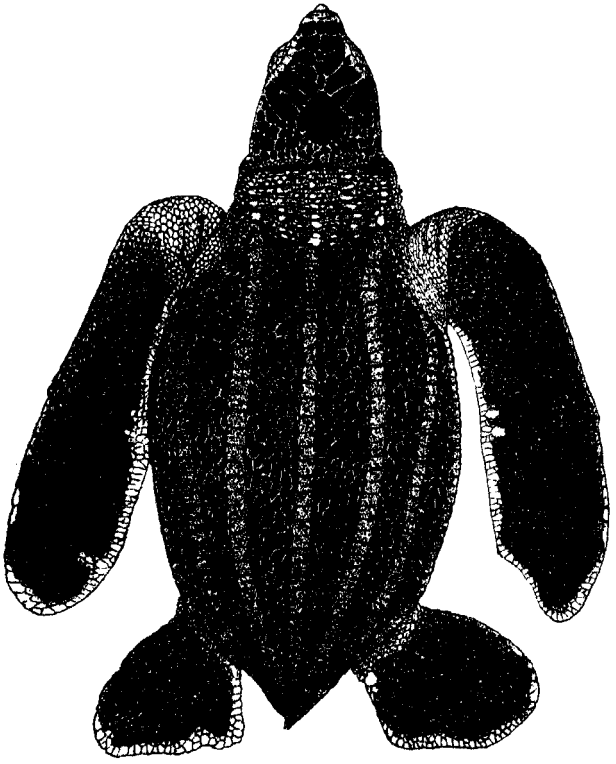

Fig. 7.—Young of *Dermochelys coriacea*, dorsal view. (After de Rooij. By kind permission of Messrs. Brill, Leiden.)

appear to frequent the outskirts of the Tangasseri Reef, off the coast of Quilon.

Very little is known about the habits of this beast. Museum collections can show only newly-born individuals and those that are sexually mature, and we may infer from this that it spends its life in fairly deep water, approaching the land only during the breeding-season. The most complete account

of its egg-laying habits is that given by Deraniyagala (Ceylon J. Sc. 1930). The hole is dug fifteen or twenty metres away from the water's edge, and is much deeper than that made by other Marine Turtles. Like the Green Turtle, the Luth, while digging her nest and depositing the eggs, is completely indifferent to the presence of spectators or noises of any kind.

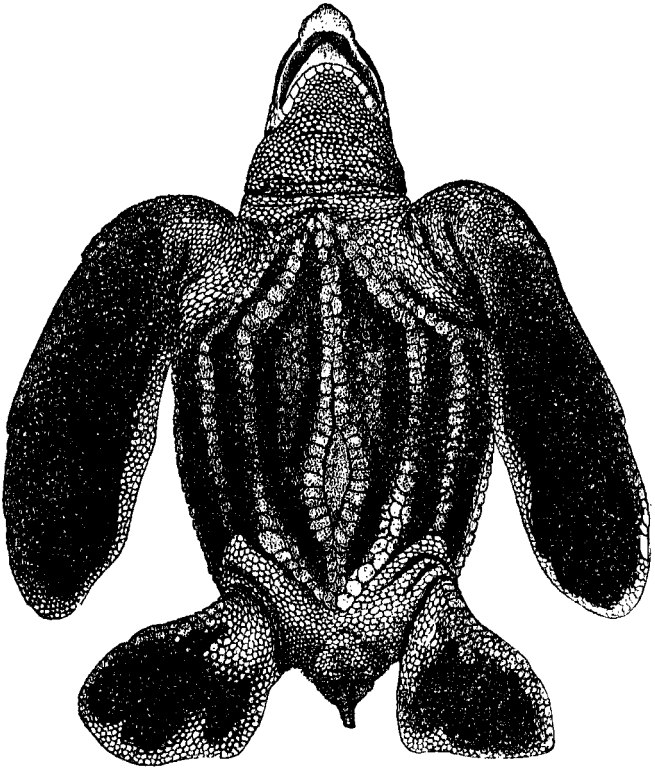

Fig. 8.—Young of *Dermochelys coriacea*, ventral view. (After de Rooij. By kind permission of Messrs. Brill, Leiden.)

After covering up the eggs, the sand is ploughed up all round for a considerable distance, so that, unless the spot has been noted at the time, it is almost impossible afterwards to locate its exact position. May and June are the chief months for oviposition, but eggs are found all the year round. Between 90 and 150 are deposited at a time and several batches are laid during the year. Normally the eggs vary

from 50 to 54 mm. in diameter, but ten or fifteen eggs in each nest are abnormal, being either very small and round or dumbbell-shaped, or of the usual size, but ellipsoid. These eggs are infertile. The period of incubation is 65–70 days. The young as soon as they are born can swim fast and dive easily.

The Leathery Turtle feeds upon crustaceans, molluscs, small fish, and marine plants. Its flesh is dark and coarse and is seldom eaten, but its eggs are much appreciated.

Suborder THECOPHORA.

Thecophora Dollo, Bull. Mus. Belg. iv, 1886, p. 91.

Carapace composed of large plates immovably united with the vertebræ and ribs.

Superfamily CARETTOIDEA.

Carettoidea Fitzinger, Neue Class. Rept. 1826, p. 5 (in part).
Cheloniidea Siebenrock, Zool. Jahrb. Jena, Suppl. x, 1909, p. 544.

Neck bending in a sigmoid curve in a vertical plane, incompletely retractile; cervical vertebræ short, mostly articulated by amphiarthrosis; outer border of tympanic cavity notched; pterygoids in contact on the median line; squamosal bone forming a suture with the parietal. Pelvis not anchylosed to the carapace and plastron. Limbs paddle-shaped, the digits of the fore-limb much elongated; phalanges without condyles. A complete set of marginal bones connected with the ribs. Carapace and plastron with horny epidermal shields.

Family CHELONIIDÆ.

Marine Turtles.

Cheloniadæ and *Carettidæ*, Gray, Ann. Phil. (2) x, 1825, p. 212.—*Chelonidæ*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 180, and Fauna Brit. Ind. 1890, p. 47.
Oiacopodes Wagler, Syst. Amphib. 1830, p. 133.
Thalassites Dum. & Bib., Erp. Gen. ii, 1835, p. 506.

Nuchal plate without costiform process. Plastral bones nine. Temporal region completely roofed over; parietals prolonged downwards towards the pterygoids. Claws one or two.

The bony shell is incomplete. The plastral elements are considerably reduced in size, a median vacuity always persisting between the two lateral halves; they are connected to the carapace by ligamentous tissue. The costal plates are more or less incomplete peripherally, fontanelles existing between

them and the marginal bones. The age at which these fill up varies in the different genera. In *Chelonia* they persist throughout life ; in *Eretmochelys* ossification is complete only in very old individuals ; in *Caretta* it is complete by the time adult life is reached.

The recent species fall into three genera, all of which have a cosmopolitan distribution in tropical and subtropical seas ; they are only occasional visitors to temperate coasts.

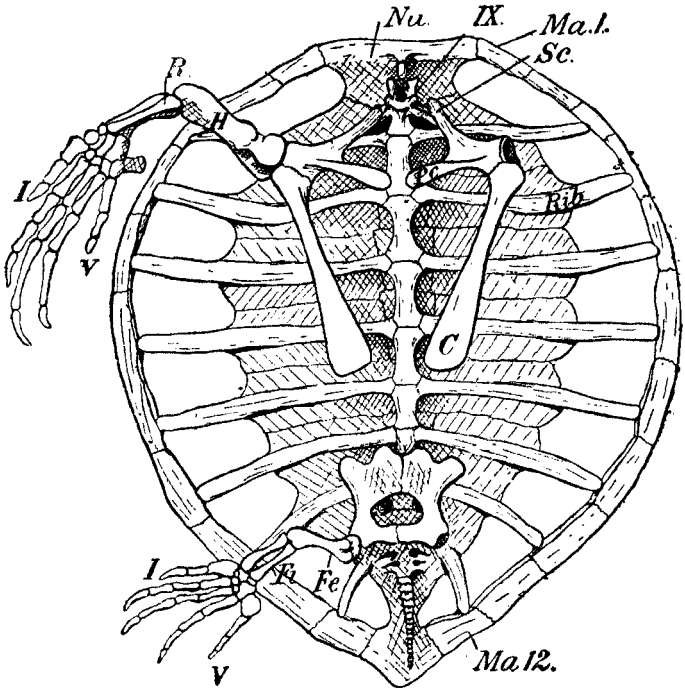

Fig. 9.—Skeleton of *Chelonia mydas*. (After Gadow. By kind permission of Messrs. Macmillan.)

Ventral view of the bony shell of *Chelonia mydas*, after removal of the plastron. The costal plates are marked with two cross-lines to distinguish them from the ribs. *C*, coracoid ; *Fe*, femur ; *Fi*, fibula ; *H*, humerus ; *Ma.* 1–*Ma.* 12, marginal plates, some of which are fused together ; *Nu*, nuchal plate ; *PC*, "precoracoid" ; *R*, radius ; *Sc*, scapula ; i, v, first and fifth digits ; ix, ninth vertebra.

The Green or Edible Turtle (*Chelonia mydas*), so called because of the green colour of its fat, is well known on account of its flesh ; the horny shields of the carapace of the Hawksbill Turtle (*Eretmochelys imbricata*) form the "tortoise shell"

of commerce; the Loggerhead (*Caretta caretta*) has no commercial value.

The eggs of all three are eagerly sought after, and the collecting of them is a regular industry, usually under Government control. They are more or less spherical in shape, about as large as golf-balls, 38 to 42 mm. in diameter, and are covered with a flexible parchment-like skin.

I have watched the Green Turtle depositing its eggs on the islands in the Gulf of Siam, and other observers have recorded their experiences of this interesting habit in India and Burma. Sandy beaches are always resorted to, and in favoured spots the turtles will congregate sometimes in huge numbers. The males follow the females about at this time, and pairing takes

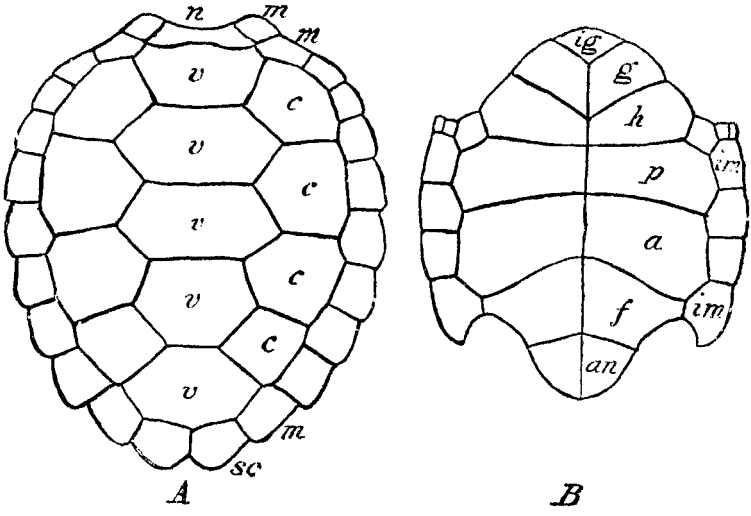

Fig. 10.—Shell of *Chelonia mydas*, showing epidermal horny shields. (After Boulenger.)

A. Carapace.

n. Nuchal.
v. Vertebral.
c. Costal.
m. Marginal.
sc. Supracaudal.

B. Plastron.

ig. Intergular.
g. Gular.
h. Humeral.
p. Pectoral.
a. Abdominal.
f. Femoral.
an. Anal.
im. Inframarginal.

place frequently, but the males do not leave the water, nor do the females except when about to deposit their eggs. The performance of egg-laying takes place at night. If disturbed when coming out of the water, the turtle will turn immediately

and retreat, but once she has commenced the operation of digging she becomes practically oblivious to her surroundings and may be watched from quite near. Even attempts to interfere with her are not always resented. In digging, all four limbs are used and with great rapidity, the sand being flung out behind in a steady stream and for a considerable distance. A hole between one and two feet deep is dug; into this the creature sinks, and then proceeds, with her hind-feet, to dig a smaller one, immediately beneath her vent, in which the eggs are deposited. Finally the hole is filled in with sand which is carefully pressed down, and all marks which would tend to show the locality of the nest are obliterated as far as possible. The mother then returns immediately to the sea.

Incubation takes between 40 and 50 days. All the young of one batch hatch out within a few hours of each other, and as soon as they emerge from the sand they run to the sea, travelling at a great pace, as if their instinct warned them of the dangers in their path. Indeed, it is probable that the most fateful time in the creature's life is the first few minutes of its existence. Predaceous birds take a large toll of them as they make their short journey to the water, while fish lie in wait to seize them as soon as they enter it. Another difficulty which the young turtle has to contend with is that it cannot, for the first day of its existence, remain under water, but is obliged to float and hide itself as best it can in masses of seaweed.

The Green Turtle and the Loggerhead are estimated to lay between 350 and 500 eggs each year, the Hawksbill not so many. They are not all laid at one time; most observers agree that three depositions are made, with a fortnight's interval between each one. Maxwell * states that the annual take of the eggs of the Green Turtle in the Irrawaddy Division is 1,600,000 or more, of the Loggerhead about one and a half millions, of the Hawksbill Turtle about 10,000. The Green Turtle, he remarks, lays all the year round, but chiefly from July to November; the Loggerhead, on the other hand, lays only from September to December; the Hawksbill Turtle lays from June to September. In conformity with the world-wide distribution of the Marine Turtles, the time of breeding is not the same everywhere.

The Marine Turtles are adapted for an entirely aquatic existence, and except during the breeding season they do not visit the land. They are fond of basking asleep, floating on the surface of the water, and in that position are frequently harpooned by native fishermen.

The scent-glands in the Cheloniidæ appear to be variable in

* 'Govt. Report on the Turtle Banks of the Irrawaddy Division, Rangoon, 1911.'

number. Axillary and inguinal glands are always present. In addition there may or may not be two or three more openings either in the inframarginal scales or beneath their

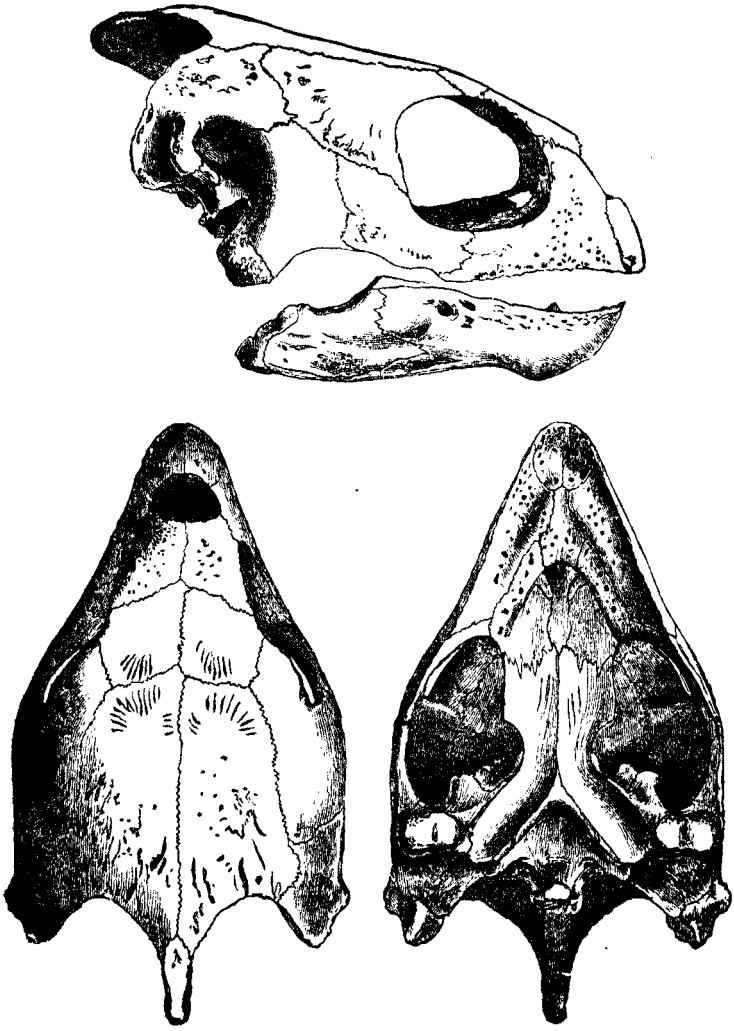

Fig. 11.—Skull of *Eretmochelys imbricata*. (After Boulenger.)

posterior edges. The total number of openings is never more than five on each side, but in many individuals these additional openings appear to be absent altogether.

Key to the Genera.

I. Four pairs of costal shields.
  Two pairs of prefrontal shields; dorsal shields imbricate (except in very old individuals); jaws hooked ..... ERETMOCHELYS, p. 67.
  One pair of prefrontal shields; dorsal shields juxtaposed; jaws not hooked . CHELONIA, p. 69.
II. Five or more pairs of costal shields; dorsal shields juxtaposed ..... CARETTA, p. 70.

Genus **ERETMOCHELYS.**

Eretmochelys Fitzinger, Syst. Rept. 1843, p. 30 (type *imbricata*).
Onychochelys Gray, Proc. Zool. Soc. London, 1873, p. 397 (type *kraussi*).
Chelone (in part), Boulenger, Cat. Chel. Brit. Mus. 1889, p. 180, and Fauna Brit. Ind. 1890, p. 48.

Four pairs of costal shields; an intergular shield and a series of inframarginal plastral shields. Head covered with symmetrical shields; two pairs of prefrontals; dorsal shields strongly imbricate, except in very old individuals in which they are juxtaposed. Jaws hooked. Tail short.

2. **Eretmochelys imbricata.**

Testudo imbricata Linn., Syst. Nat. ed. 12, 1766, p. 350.—*Eretmochelys imbricata*, Agassiz, Contr. Nat. Hist. U.S. i, 1857, p. 381; Deraniyagala, Ceylon J. Sc., Sect. B, xvi, 1930, p. 70, pls. xi–xii.
Chelone imbricata, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 183, and Fauna Brit. Ind. 1890, p. 49; Gadow, Amphib. & Rept. 1901, p. 384; Hornell, The Turtle Fisheries of the Seychelles Is., H.M. Stat. Off. 1927.
Chelonia imbricata, Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 547.
Chelonia pseudo-mydas Lesson, in Bélang. Voy. Ind. Or., Zool. 1834, p. 299 (type loc. Atlantic Ocean).
Chelonia pseudo-caretta Lesson, t. c. p. 302 (type loc. Atlantic Ocean).
Caretta bissa Rüppel, N. Wirbelth. Abyss., Amph. 1835, p. 4, pl. 2 (type loc. Red Sea).
Eretmochelys squamata Agassiz, Contr. Nat. Hist. U.S. i, 1857, p. 382.—*Caretta squamata*, Günther, Rept. Brit. Ind. 1864, p. 54.
Caretta squamosa Girard, U.S. Explor. Exp., Herp. 1858, p. 442, pl. 30 (type loc. Indian Ocean).—*Eretmochelys squamosa* Stejneger, Herpet. Japan, 1907, p. 511, figs.
Caretta rostrata Girard, t. c. p. 446, pl. 30.
Onychochelys kraussi Gray, Proc. Zool. Soc. 1873, p. 398, figs. (type loc. coast of French Guinea; Brit. Mus.).

Carapace tricarinate in the young, with the shields strongly imbricate, the vertebrals rhomboidal; dorsal shields of adult smooth, juxtaposed in very old individuals; margin formed of 25 shields, more or less strongly serrated posteriorly. Snout compressed in the adult; jaws hooked, the edges not or but feebly denticulated; two pairs of shields anterior to the azygous frontal; symphysis of lower jaw long; limbs usually with two claws.

Young brown above, blackish below. Carapace of adult marbled yellow and dark brown, plastron yellow ; shields of head and limbs dark brown with yellow borders.

Length of shell 850 mm.

Range. Tropical and subtropical seas. The Hawksbill Turtle is generally distributed in Indian and Indo-Chinese waters, but not so plentifully as either the Green Turtle or the Loggerhead.

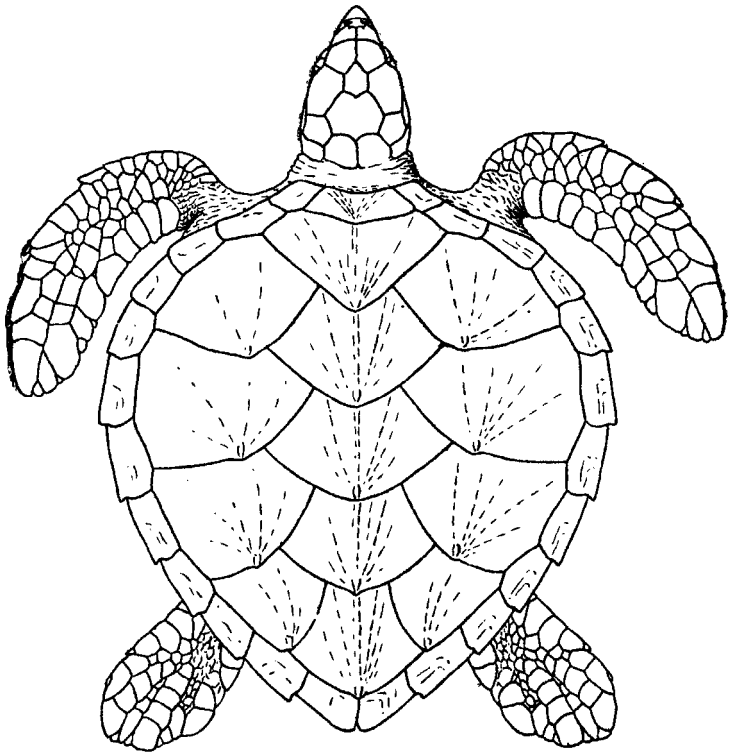

Fig. 12.—*Eretmochelys imbricata*, dorsal view.

It feeds chiefly upon molluscs and fish, but also on marine plants. The eggs are deposited in the same manner as has been described for the Green Turtle, but according to Hornell the operation takes place during the day instead of by night. Incubation takes about 60 days.

The horny shields of its carapace form the " tortoise-shell " of commerce. Mr. Deraniyagala, of the Ceylon Government Fisheries, informs me that the Sinhalese remove the scutes from the living creature by heat, smearing the shell with

sesamum oil and holding it over a lighted taper until the scutes are sufficiently loose to be detached with a knife. The whole of the scute is not always taken away and the nuchal scute never, as its removal is said to kill the animal. The turtle is then returned to the sea. The reason for this cruel procedure lies in their belief that the shell will in time be regenerated, and the process can then be repeated. Deraniyagala (Ceylon J. Sc.) records the complete regeneration of one costal scute together with the upper halves of the two adjacent marginals in a very young individual (156 mm. in length of carapace), but whether the adult would survive the removal of nearly all its scutes is extremely doubtful. In Celebes, where the finest tortoise-shell is said to come from, the turtle is killed by blows on the head and the shields are removed by immersing the shell in boiling water.

It is essential that the shields should be removed whilst the flesh is still fresh. If taken from the creature some time after death, the horn has a dried-up and clouded appearance and its beautiful pattern, which is so much admired, is gone. A large turtle will yield about eight pounds of shell. A single scute is neither large enough nor thick enough to be of any use by itself, and so a number are welded together under pressure after being heated in oil or water. The shell is then sufficiently soft and pliable to be worked into the desired shape. Much artificial tortoise-shell is now made, and in appearance it is not far behind the real article, but it is heavier and considerably more brittle.

The flesh of the Hawksbill Turtle is not usually eaten. Deraniyagala states that it is said to be poisonous after the creature has fed upon certain algæ, and he records cases of sickness and death in human beings after having partaken of it.

Genus **CHELONIA.**

Chelonia Brongniart, Bull. Sci. Soc. Philom. ii, 1800, p. 89; Latreille, Hist. Nat. Rept. i, 1802, p. 22 (type *mydas*); Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 545.—*Chelone* (in part), Boulenger, Cat. Chel. Brit. Mus. 1889, p. 180, and Fauna Brit. Ind. 1890, p. 48.

Mydas Cocteau, in Sagra's Hist. Fis. Pol. Nat. Cuba, iv, 1838, p. 22 (type *mydas*).

Mydasea Gervais, Dict. Hist. Nat. iii, 1843, p. 457 (type *mydas*).

Euchelonia Tschudi, Fauna Peruana, 1845, p. 22 (type *mydas*).

Megemys Gistel, Naturg. Thier. 1848, p. 8 (type *mydas*).

Euchelys Girard, Herpet. U.S. Expl. Exp. 1858, p. 447 (type *Testudo macropus* Walb.).

Natator McCulloch, Rec. Austr. Mus. vii, 1908, p. 126 (type *tessellatus*).

Four pairs of costal shields. An intergular shield and a series of inframarginal plastral shields. Head covered with symmetrical shields; one pair of prefrontals; dorsal shields juxtaposed. Jaws not hooked. Tail short.

3. Chelonia mydas.

Testudo mydas Linn., Syst. Nat. ed. 10, 1758, p. 197 (type loc. Ascension I.; Mus. Upsala).—*Chelone mydas*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 180, and Fauna Brit. Ind. 1890, p. 49; Mawson, J. Bombay Nat. Hist. Soc. xxvii, 1921, p. 956; Hornell, Turtle Fisheries of Seychelles Is., H.M. Stat. Off. 1927.—*Chelonia mydas*, Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 545; Deraniyagala, Ceylon J. Sc., Sect. B, xvi, 1930, p. 66, pls. xi–xii.

Testudo japonica Thunberg, Sven. Vet.-Akad. Handl. viii, 1787, p. 178, pl. 7 (type loc. Japan).—*Chelonia japonica*, Stejneger, Herpet. Japan, 1907, p. 509, figs.

Caretta thunbergi Merrem, Syst. Amphib. 1820, p. 19 (type loc. Japan).

Chelonia depressa Garman, Bull. Mus. Comp. Zool. vi, 1880, p. 124 (type loc. E. Indies and N. Australia; Harvard Mus. Comp. Zool.); Fry, Rec. Austr. Mus. x, 1913, p. 159, text-figs. & pls. xix–xxi.

Natator tessellatus McCulloch, Rec. Austr. Mus. vii, 1908, p. 126, pls. xxvi & xxvii (type loc. Port Darwin; Austral. Mus., Sydney).

For full synonymy of this widely-spread species see Stejneger and Siebenrock.

Carapace feebly unicarinate in the young, sometimes with slight indications of lateral keels, arched or subtectiform in the adult; dorsal shields juxtaposed; margin formed of 25 shields, not or but feebly serrated. Snout short, horny sheath of upper jaw with feebly, of lower jaw with strongly, denticulated edge: alveolar surface of upper jaw with two strong denticulated ridges; symphysis of lower jaw short; one pair of prefrontal shields. Limbs usually with a single claw, the second digit sometimes clawed in the young.

Young olive or dark brown above, the limbs with yellow margins; yellow below, with a large dark patch on each hand and foot. Adult olive or brown, the shields with more or less distinct dark rays; yellowish below.

Length of shell 1100 mm.

Range. Tropical and subtropical seas. Generally distributed throughout Indian and Indo-Chinese waters. Particularly common in the vicinity of the Andaman Islands.

The Green Turtle feeds almost exclusively upon marine algæ, but will also take molluscs, crustaceans, and fish. According to Hornell the young feed upon fine confervæ and on the tender leaves of a sea-grass (*Cymodea*). The adult lives almost entirely upon this sea-grass, and its distribution, except when it approaches the land to breed, depends upon where this grass is to be found.

Genus CARETTA.

Caretta Rafinesque, Specchio Sci. Palermo, ii, 1814, p. 66 (type *C. nasuta*); Stejneger, Rept. U.S. Nat. Mus. no. 129, 1904, p. 714.

Thalassochelys Fitzinger, Ann. Wien. Mus. i, 1835, p. 121 (type *Testudo caouana*); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 184, and Fauna Brit. Ind. 1890, p. 50.

Caouana Cocteau, in Sagra's Hist. Fis. Pol. Nat. Cuba, iv., Rept. 1838, p. 31 (type *Chelonia cephalo*).
Lepidochelys Fitzinger, Syst. Rept. 1843, p. 30 (type *Chelonia olivacea*).
Colpochelys Garman, Bull. Mus. Comp. Zool. Harvard, vi, 1880, p. 123 (type *kempi*).
Cephalochelys Gray, Proc. Zool. Soc. 1873, p. 408 (type *oceanica*).
Eremonia Gray, t. c. p. 408 (type *Caouana elongata*).

Five or more pairs of costal shields; intergular shield present or absent. A series of inframarginal plastral shields. Head covered with symmetrical shields; two pairs of prefrontals. Tail short.

The most interesting character of this genus is the variation in the number of the shields of the carapace. It affects chiefly the costal shields, but sometimes also the neurals. Examples from the Indian and Pacific Oceans show more instability in this respect than those from other parts of its range. They usually have more than five pairs of costal shields, as many as eight pairs having been recorded (Gadow). The number, however, is very variable and is seldom the same on both sides. Individuals from the Atlantic Ocean usually have five pairs only. Babcock (1930) states that in 88 specimens of the Atlantic form examined by him, 81 had five pairs of costals, whereas in 32 specimens from the Indian and Pacific oceans, 29 had more than five pairs of costals. Deraniyagala, working on material from the coast of Ceylon, found also that most of the individuals examined by him had more than five pairs. Eschscholtz's name therefore must be used for the Indian form.

4. Caretta caretta olivacea.

Testudo caretta Linn., Syst. Nat. ed. 10, 1758, p. 197 (type loc. "Isles of America").—*Thalassochelys caretta*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 184, and Fauna Brit. Ind. 1890, p. 50; Gadow, Amphib. & Rept. 1909, p. 387.—*Caretta caretta*, Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 549; Babcock, Amer. Nat. lxiv, 1930, p. 1; Deraniyagala, Ceylon J. Sc., Sect. B, xvi, 1930, p. 79, pls. xi–xiii.
Chelonia olivacea Eschscholtz, Zool. Atlas, 1829, p. 3, pl. 3 (type loc. Manila Bay).—*Caretta olivacea*, Stejneger, Herpet. Japan, 1907, p. 507, pl. 34 & figs.
Chelonia dussumieri Dum & Bib., Erp. Gen. ii, 1835, p. 557, pl. 24 (subst. name for *olivacea*).

The above synonymy refers chiefly to the Asiatic form.

Carapace of the young with three strong keels, of the adult arched or tectiform, without any trace of keels; margin more or less serrated posteriorly, formed usually of 27, rarely 25, shields. Intergular shield absent or very small, sometimes divided in two. Head large, with very strong, hooked jaws; symphysis of lower jaw very long; alveolar surface of horny beak with a median ridge, absent on the jaws. Two pairs

of prefrontal shields, which are again sometimes divided irregularly. Limbs with one or two claws in the adult usually two in the young.

Young uniform dark brown or blackish, paler below. Adult brown above, yellowish below.

Length of shell 1050 mm.

The Loggerhead is more widely distributed than the two preceding species, ranging further north; it occurs in the Mediterranean. It is generally distributed in Indian waters, and, like the preceding species, is particularly abundant in the vicinity of the Andaman Islands and on the coast of Ceylon. It is rare in the Gulf of Siam.

It feeds chiefly on molluscs and crustaceans.

Deraniyagala states that the breeding-season in Ceylon is from September to January. The nest, which is about 30 cm. in depth, is generally scooped out under shelter of the *Pandanus*-scrub about 50 metres from the sea. Between 90 and 135 eggs are deposited at one time.

Superfamily CRYPTODIRA.

Cryptodira Cope, Proc. Amer. Ass. Adv. Sc. xix, 1870, p. 235 (in part); Boulenger, Fauna Brit. Ind. 1890, p. 18 (in part).

Neck bending in a sigmoid curve in a vertical plane, completely retractile; centrum of the last cervical vertebra articulating with the centrum of the first dorsal; outer border of tympanic cavity deeply notched; pterygoids narrow in the middle, in contact in the median line; squamosal bone widely separated from the parietal. Pelvis not anchylosed to the carapace and plastron. Digits distinct, with not more than three phalanges; phalanges with condyles; claws four or five. A complete set of marginal bones connected with the ribs. Shell with epidermal horny shields.

Family PLATYSTERNIDÆ.

Platysternidæ Gray, Cat. Sh. Rept., Suppl. i, 1870, p. 69; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 45, and Fauna Brit. Ind. 1890, p. 44.
Cinosternidæ (in part) Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 449.

Neck retractile within the shell. Temporal region completely roofed over; parietals separated from squamosals; jugal surrounded by bones, excluded from the orbit. Phalanges with condyles, claws four and five. Nuchal plate without costiform process. Plastral bones nine. Plastral shields separated from the marginals by inframarginals. Tail very long.

A single genus and species.

Genus **PLATYSTERNUM.**

Platysternon Gray, Proc. Zool. Soc. 1831, p. 106.—*Platysternum*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 45, and Fauna Brit. Ind. 1890, p. 44.

Plastron connected to the carapace by ligamentous tissue. Head very large, covered with an undivided horny shield;

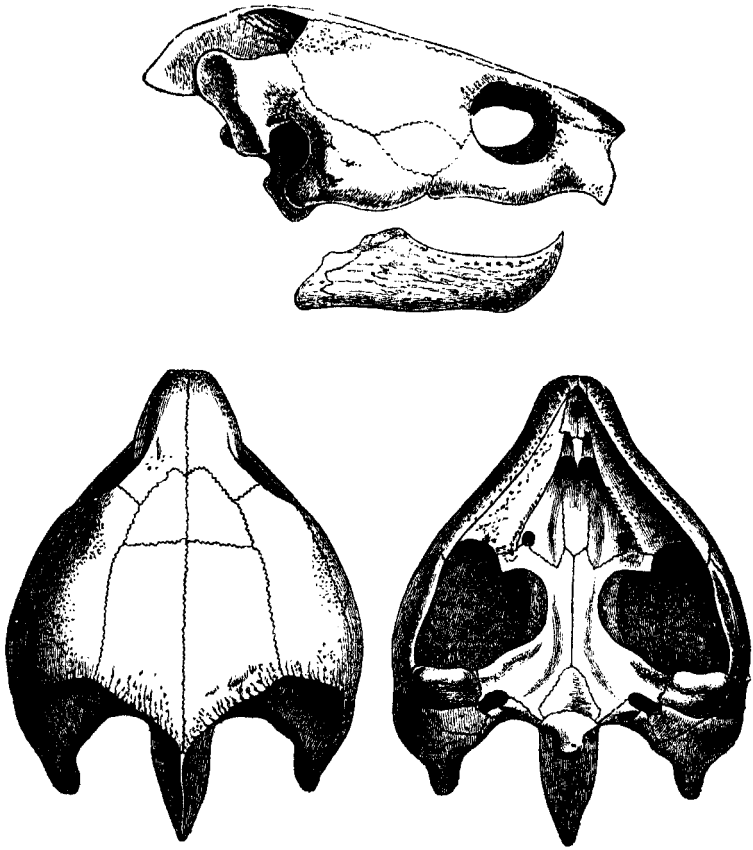

Fig. 13.—Skull of *Platysternum megacephalum*. (After Boulenger.)

jaws powerful, strongly hooked. Digits not quite fully webbed, all except the outer toe clawed. Tail as long as or longer than the shell, covered with rings of squarish shields. Axillary and inguinal scent-glands present.

5. Platysternum megacephalum.

Platysternon megacephalum Gray, Proc. Zool. Soc. London, 1831, p. 107, and Illus. Ind. Zool. ii, 1834, p. 62 (type loc. China; Brit. Mus.); Theobald, J. Linn. Soc. London, x, 1868, p. 17; Stejneger, Proc. U.S. Nat. Mus. lxvi, 1925, art. 25, p. 102; Schmidt, Bull. Amer. Mus. Nat. Hist. N. York, liv, 1927, p. 400, fig.—*Platysternum megacephalum*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 46, and Ann. Mag. Nat. Hist. (5) xix, 1887, p. 461, pls. xvi & xvii (osteology), and Fauna Brit. Ind. 1890, p. 44, figs. 13 & 14; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 450; Mell., Arch. Naturg. Berlin, Heft 10, 1922, p. 108.

Platysternon peguense Gray, Cat. Sh. Rept. i, 1870, p. 70 (type loc. Pegu; Brit. Mus.).

Carapace much depressed with a feeble median keel; posterior margin serrated in the young. Nuchal shield very small, broader than long; vertebrals broader than long, as broad as or a little narrower than the costals in the adult, much broader in the young. Front lobe of plastron squarish, hind lobe angularly emarginate; bridge narrow, its width contained four or five times in the length of the plastron. The longest plastral shields are the anals, the femorals, or the humerals; the shortest the gulars, which occupy the whole of the front border of the plastron; a small intergular shield between the gulars and the humerals frequently present.

Upper surface of head covered with a large undivided horny scute; throat with round flat tubercles. Limbs with large, squarish or pointed, horny scales; hinder part of thighs with conical tubercles.

Colour of adult: shell olive or reddish-brown above, the shields sometimes with fine black radiating lines; yellowish below with dark brown blotches; soft parts brown. Colour of young: shell reddish-brown above, with a black spot in the centre of each costal scute; yellow below (orange in life), with dark symmetrical markings along the middle of the plastron; soft parts reddish-brown above; a yellow stripe bordered with black extending backwards from behind the eye; yellow below (pink in life), with a black streak along the middle of the tail.

Length of carapace 155, breadth 125, depth 50 mm.

Range. Southern Burma; Siam; French Indo-China; Southern China; Hainan. Taylor doubts its occurrence in the Philippines (Philipp. J. Sc., Manila, xvi, 1920, p. 113).

Platysternum megacephalum inhabits mountain streams; usually in remote and more or less uninhabited districts. It is a good climber, ascending trees and rocks in search of food and to bask in the sun. One that I kept fed freely on snails and worms.

Family EMYDIDÆ.

THE FRESHWATER TORTOISES—TERRAPINS.

Emydidæ Gray, Ann. Phil. (2) x, 1825, p. 210.
Testudinidæ (in part), Boulenger, Cat. Chel. Brit. Mus. 1889, p. 48, and Fauna Brit. Ind. 1890, p. 18 (in part).—*Emydinæ*, Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 451.

Neck completely retractile within the shell. Nuchal plate without well developed costiform process: plastral bones nine. Ear chamber not completely closed behind, the stapes being more or less exposed. Temporal region not roofed over; a bony temporal arch present or absent; digits more or less webbed, the median with three phalanges; metacarpals elongate; claws four or five. Shell covered with epidermal shields, those of the plastron in contact with the marginals. Head covered above with smooth skin or with the posterior part of it divided into shields.

Eggs oval, elongate.

Range. Cosmopolitan, except Australia and Papuasia. Some 20 genera are recognized.

The *Emydidæ* comprise the large group commonly known as the Freshwater Tortoises. Their separation from the typical Land Tortoises (*Testudinidæ*), although dependent upon small characters only, is quite distinct. Both families appear equally old. Such of the *Emydidæ* (i. e., *Geoemyda* species) as have acquired terrestrial habits and a superficial resemblance to the *Testudinidæ* are more probably examples of parallel evolution than of forms connecting the two families.

The determination of the many genera included under the *Emydidæ* is not easy and depends largely upon internal characters. The shape of the neural plates is important. Aberrant individuals showing deviation from the normal are not uncommon, but on the whole the character can be relied upon. The plates may be tetra-, hexa-, or octagonal. When hexagonal the antero-lateral and postero-lateral sides are usually of unequal lengths (short-sided in front or behind). The first neural plate is usually tetragonal, the last two or three are small and usually short-sided in front, and for the purposes of the key given here they need not be considered. The examination of the neural plates is not difficult in fresh or spirit specimens. With care the epidermal shields which cover them can be stripped off entire and afterwards gummed on again; or they may be kept loose in the bottle with the specimen.

All the genera mentioned in this work have axillary and inguinal scent-glands.

A critical examination of the Indian Emydidæ has convinced me that their generic characters have not always been fully investigated, and in consequence I have been induced to make some changes. *Damonia* Gray has been revived as a monotypic genus, and *Chinemys* has been erected for the species hitherto known as *Damonia* (or *Geoclemys*) *reevesi*. *Cuora* has been revived and separated from *Cyclemys*.

It is doubtful if the characters that are usually regarded as generic—such as the position of the entoplastron in relation to the humero-pectoral suture, the breadth of the alveolar surfaces of the jaws and the presence or absence of ridges upon them, and the level of the choanæ with regard to the orbits—are really sound ones, but in the absence of better we are compelled to use them. Certainly too much emphasis has been placed by recent workers upon the scalation, or division of the skin of the hinder part of the head, a character that is subject to considerable individual variation. The fact of the matter is that the Chelonians are a very old group and there has been time for a degree of individualisation in many of them which must be regarded as something more than specific. The result is that we must now either recognize a number of monotypic genera or else unite them. The former appears to be the wiser course.

Emys siamensis Gray, Proc. Zool. Soc. London, 1860, p. 114, appears to be a clerical error.

Key to the Genera.

I. Hexagonal neural plates short-sided behind.

A. Plastron united to carapace by ligamentous tissue; a more or less distinct transverse hinge.

Plastron not completely closing the shell; a short but distinct bridge; front lobe of plastron feebly movable ..... CYCLEMYS, p. 78.

Plastron completely closing the shell; no distinct bridge; both lobes of plastron movable ..... CUORA, p. 84.

B. Plastron united to carapace by suture.

Alveolar surfaces of jaws narrow; bony choanæ on a level with the front part of the orbits; entoplastron intersected by the humero-pectoral suture * ..... GEOEMYDA, p. 88.

Alveolar surfaces of jaws broad; bony choanæ on a level with the middle or hinder part of the orbits.

II. First hexagonal neural plate short-sided in front, the succeeding hexagonal plates short-sided behind.

a. A bony temporal arch; entoplastron anterior to the humero-pectoral suture ..... DAMONIA, p. 103.

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* Not always in *G. trijuga edeniana*.

b. Temporal arch incomplete; entoplastron intersected by the humero-pectoral suture ..... HIEREMYS, p. 106.

III. Hexagonal neural plates short-sided in front.

A. Plastron united to carapace by ligamentous tissue. Six or seven vertebral shields ..... NOTOCHELYS, p. 109.

B. Plastron united to carapace by suture.

a. Axillary and inguinal buttresses short, not extending half-way along the costal plates.

1. Alveolar surfaces of jaws broad or narrow, without median ridge.

Entoplastron anterior to the humero-pectoral suture; alveolar surfaces of jaws broad; choanæ behind the level of the eyes; skin of hinder part of head divided into small shields; tail very short..... GEOCLEMYS, p. 111.

Entoplastron intersected by the humero-pectoral suture; alveolar surfaces of jaws narrow; choanæ on a level with the middle of the eyes; skin of hinder part of head divided into small shields; tail very short.. SIEBENROCKIELLA, [p. 112.

Entoplastron intersected by the humero-pectoral suture *; alveolar surfaces of jaws narrow; choanæ on a level with the front of the eyes; skin of hinder part of head smooth; tail moderate or long ..... CLEMMYS, p. 114.

Entoplastron intersected by the humero-pectoral suture; alveolar surfaces of jaws broad; choanæ on a level with the middle of the eyes; skin of hinder part of head divided into small shields; tail moderate or long ..... CHINEMYS, p. 116.

2. Alveolar surfaces of jaws broad, with a median ridge.

Entoplastron intersected by the humero-pectoral suture; choanæ on a level with the middle of the eyes; skin of hinder part of head smooth ..... OCADIA, p. 118.

Entoplastron anterior to the humero-pectoral suture; choanæ behind the level of the eyes; skin of hinder part of head divided ..... MORENIA, p. 119.

b. Axillary and inguinal buttresses extensively developed, extending nearly to the neural plates, the former connected with the first rib; entoplastron anterior to the humero-pectoral suture; alveolar surfaces of jaws broad, with one or two median ridges.

Fourth vertebral shield not longer than broad, not longer than third; fore-limb with 5 claws. HARDELLA, p. 122.

Fourth vertebral shield elongate, much longer than broad, much longer than third; fore-limb with 5 claws ..... KACHUGA, p. 124.

Fore-limb with 4 claws only..... BATAGUR, p. 134.

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* Except in *C. mutica*.

Genus CYCLEMYS.

Cyclemys Bell, Proc. Zool. Soc. 1834, p. 17 (type *orbiculata*); (in part) Boulenger, Cat. Chel. Brit. Mus. 1889, p. 128, and Fauna Brit. Ind. 1890, p. 28; Stejneger, Proc. Biol. Soc. Washington, xv, 1902, p. 237; Siebenrock, SB. Akad. Wiss. Wien, cxii, Abt. 1, 1903, p. 340 (in part).

Pyxidea Gray, Proc. Zool. Soc. 1863, p. 175 (type *mouhoti*); Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 505.

Hexagonal neural plates short-sided behind. Plastron not completely closing the shell, united to the carapace by ligamentous tissue; a short but quite distinct bridge; an indistinct hinge between the hyo- and hypoplastral bones, only the front lobe of the plastron movable; entoplastron intersected by the humero-pectoral suture. Skull with a bony temporal arch; alveolar surfaces of jaws narrow. Digits half to fully webbed. Tail moderate or short in the adult, longer in the young. Three species.

Range. Assam; Burma; Siam; French Indo-China; the Malay Peninsula and Archipelago.

The transverse hinge between the hyo- and hypo-plastral bones which occurs in this genus is not evident at birth; it develops later in life and becomes more distinct as the creature grows older. Individuals, however, are variable in this respect, and in some it does not develop at all, as in Annandale's *Cyclemys dhor shanensis*.

Key to the Species.

Carapace strongly tricarinate, greatly flattened on the vertebral region; digits half webbed; head without stripes	*mouhoti*, p. 78.
Carapace unicarinate, not flat on the vertebral region; digits fully webbed; neck with or without pale stripes; plastron yellow with dark rays, or brown all over	*dentata*, p. 80.
Carapace tricarinate in the young, not flat on the vertebral region; digits fully webbed; head and neck with yellow stripes; plastron yellow, with dark symmetrical blotches	*annamensis*, p. 83.

6. Cyclemys mouhoti.

Cyclemys mouhoti Gray, Ann. Mag. Nat. Hist. (3) x, 1862, p. 157 (type loc. Laos Mountains, Annam–Siam border; Brit. Mus.); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 132, and Fauna Brit. Ind. 1890, p. 31.—*Pyxidea mouhoti*, Günther, Rept. Brit. Ind. 1864, p. 16, pl. 4; Jerdon, P. Asiat. Soc. Bengal, 1870, p. 68; Siebenrock, SB. Akad. Wiss. Wien, cxii, Abt. 1, 1903, p. 345, fig. (skull); Schmidt, Bull. Amer. Mus. Nat. Hist. N. York, liv, 1927, p. 407, fig.

Carapace depressed, with three strong keels, between which the shell is much flattened; anterior and posterior margins serrated, the latter strongly. Nuchal shield long and narrow;

first vertebral narrower behind than in front in the adult, narrower than the second; second, third, and fourth vertebrals much broader than long, as broad, or nearly as broad, as the costals *. Plastron smaller than the opening of the shell,

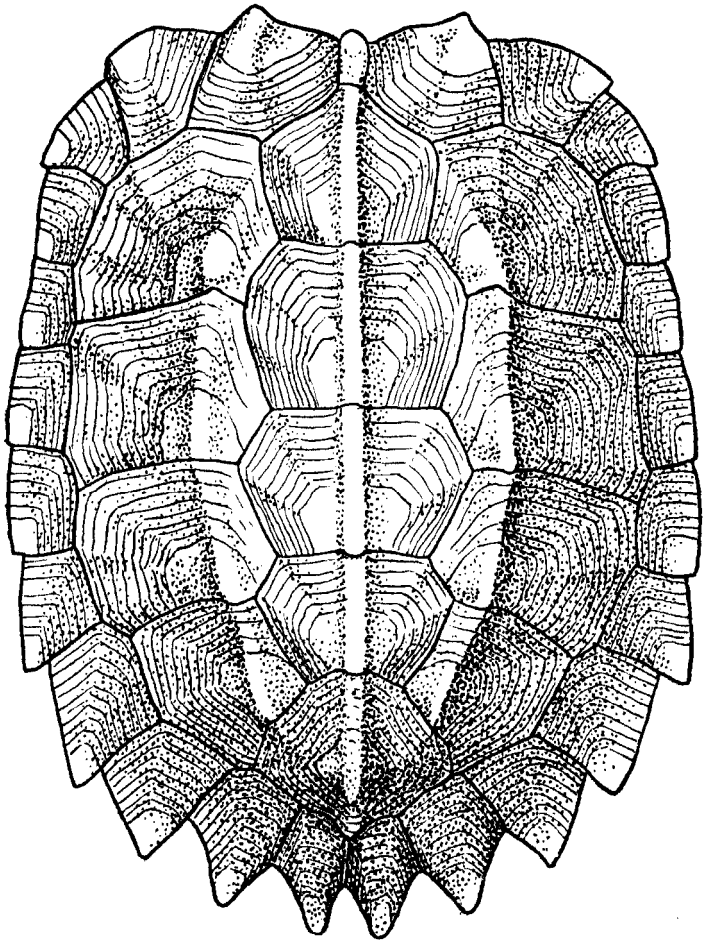

Fig. 14.—Shell of *Cyclemys mouhoti*, dorsal view.

truncate anteriorly, notched posteriorly. The longest median suture is between the abdominal shields, the shortest between the gular.

* A specimen from Tonkin, in the Vienna Museum of Natural History, has the costals divided so that there are six shields on one side and seven on the other.

Bridge short but quite distinct, its width one-third the length of the plastron; the hypoplastral bone contributes more to the formation of the bridge than the hyoplastral; the suture between the pectoral and the abdominal shields corresponds with the hinge between the hyo- and hypoplastra; an axillary shield sometimes present.

Head moderate, snout shorter than the orbit, truncate; upper jaw with a strong mesial hook; skin of the hinder part of the head divided into rather large shields. Fore-arm entirely covered with large, imbricate, horny shields; hind-limb club-shaped, the lower part of it and the sole of the foot with imbricate, more or less pointed, horny shields. Digits half webbed; tail moderate, its base and the adjacent skin of the thighs with pointed tubercles.

Shell light brown above, uniform or with the costal plates exterior to the lateral keels dark brown; yellowish-brown below, usually with a dark spot on each shield. Head brownish, with dark vermiculations and one or more light dark-edged spots on the temporal region.

Length of shell 160, breadth 112, depth 58 mm.

Range. Assam; French Indo-China; Hainan. The types were collected by Mouhot in the Laos mountains, somewhere on the Annam-Siam frontier; Siebenrock (1903) records it from Than-moi, N.E. of Hanoi, in Tonkin: there is a specimen in the Paris Museum of Natural History labelled Cochin-China. Of the Assam specimens Jerdon records that "a few shells" were collected by Major Godwin-Austen in North Cachar. One of these is in the British Museum collection.

A hatchling from the hills of eastern Assam (Brit. Mus. Coll., ? Barail range) I refer provisionally to this species. It differs from the above description in having the anterior margin of the carapace not serrated. The tail is half the length of the plastron. The shell above is dark brown, the vertebral keel pale, with a black border. The plastron is yellow, with a large dark-brown symmetrical mark.

In all external characters *C. mouhoti* bears a remarkable resemblance to *Geoemyda spengleri*.

7. Cyclemys dentata.

Emys dhor (in part) Gray, Syn. Rept. i, 1831, p. 20 (corrected to *dentata* in Errata), and Ill. Ind. Zool. ii, 1834, pl. 58, fig. 2 only (type loc. Java; Brit. Mus.).—*Cyclemys dentata*, Gray, Cat. Sh. Rept. 1855, p. 42, pl. 19.—*Cyclemys dhor*, Gray, Cat. Sh. Rept., Suppl. 1, 1870, p. 23; Morice, Coup d'œil faune Cochinchine, 1875, p. 63; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 131, and Fauna Brit. Ind. 1890, p. 30; Siebenrock, SB. Akad. Wiss. Wien, cxii, Abt. 1, 1903, p. 341; M. A. Smith, Bull. Raffles Mus. Singapore, no. 3, 1930, p. 8.

Cyclemys orbiculata Bell, Proc. Zool. Soc. 1834, p. 17, and Monog. Testud. 1842, no pag., pt. 8, pls. 2 & 3 (type loc. "India"; Brit. Mus.); Theobald, Cat. Rept. Mus. Asiat. Soc. 1868, p. 10, and J. Linn. Soc. Zool. x, 1868, p. 12; Sowerby & Lear, Tort., Terr. & Turtles, 1872, pls. xxiv & xxv.

Cistudo diardi Dum. & Bib., Erp. Gen. ii, 1835, p. 227 (subst. name).

Cyclemys oldhami Gray, Proc. Zool. Soc. 1863, p. 178 (type loc. Mergui; Brit. Mus.); Günther, Rept. Brit. India, 1864, p. 15, pl. v.

Cyclemys ovata Gray, idem, p. 178 (type loc. Sarawak, Borneo; Brit. Mus.).

Cyclemys belli Gray, idem, p. 179.

Cyclemys dhor shanensis Annandale, Rec. Ind. Mus. xiv, 1918, p. 67, pl. xx (type loc. Inle Lake, Burma; Ind. Mus.).

Carapace depressed, much flattened and nearly as broad as long in the young, more arched and elongate in the adult; vertebral region with a strong obtuse keel in the young which disappears almost entirely in aged individuals; posterior margin strongly serrated in the young, less marked in the adult. Nuchal shield moderate; first vertebral usually broader in front than behind in the young, the reverse in the adult, in which it has sinuous lateral borders; second to fourth vertebrals as broad as long or broader than long, narrower than the costals. Plastron narrower than the opening of the shell, truncate or openly emarginate anteriorly, notched posteriorly; the longest median suture is usually between the pectoral shields, the shortest between the humeral or the gular, but there is great variety in the lengths of the different sutures. Bridge short but distinct, about two-fifths the length of the plastron; the hyo- and hypoplastral bones contribute in a nearly equal degree to the formation of the bridge; the transverse hinge between them is not developed until adult life, and does not correspond with the curved suture between the pectoral and abdominal shields; a small inguinal shield may be present.

Head moderate; snout shorter than the orbit, slightly projecting beyond the lower jaw; upper jaw feebly bicuspid; skin of hinder part of head divided into rather large shields; digits fully webbed; limbs with transversely enlarged scales; tail moderate, longer in the young than in the adult.

Shell dark brown or olive-brown or black above, uniform or with fine black rays; yellowish below, uniform or with dark rays, or entirely dark brown or black; juveniles have usually a handsome chestnut tinge all over the shell. Head brown, with or without small black spots; neck pale yellowish with dark longitudinal streaks. A shell from Pegu in the British Museum collection is light brown with black spots and markings. The considerable variations in coloration in this species are not correlated with geographical distribution.

Length of shell 240, breadth 175, depth 82 mm.

Range. The Indo-Chinese Peninsula; the Malay Peninsula and Archipelago; the Philippine Islands. In Burma it extends as far north as lat. 25° (the Garo and Khasi Hills and

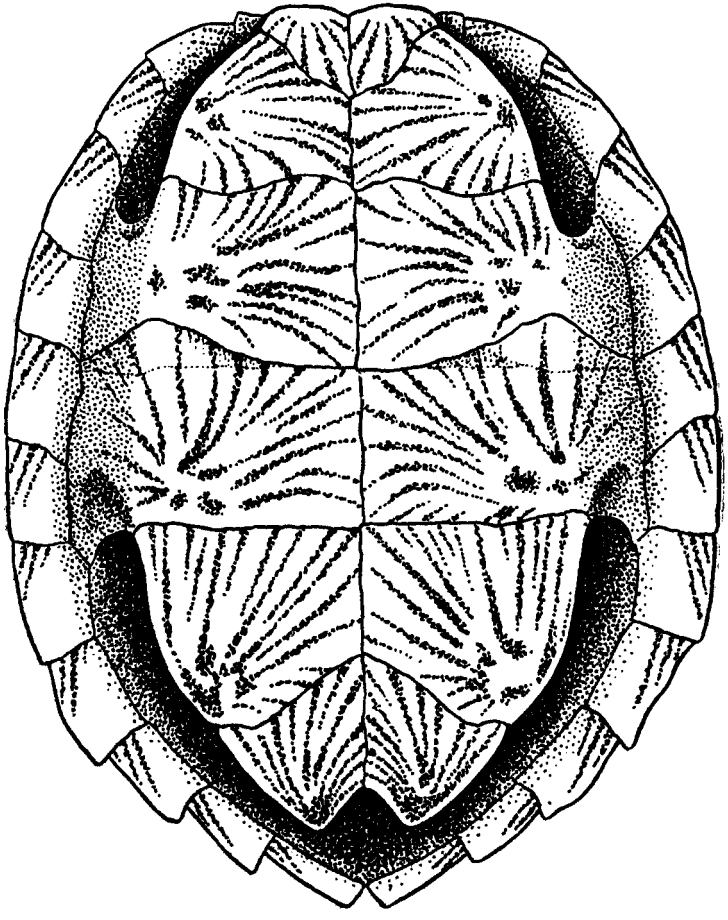

Fig. 15.—Shell of *Cyclemys dentata*, ventral view.

Myitkyina district); Siebenrock records it from Annam (Phuc-Son).

C. dentata is the commonest Water Tortoise of the hill streams of Tenasserim, Siam, and Cambodia. It has been

found at over 4000 feet altitude, but is commoner at lower levels. It is an active creature with a voracious appetite, devouring both animal and vegetable food. In captivity it soon becomes tame. It lays from two to four eggs at a time; they measure about 57 mm. in length by 30 in breadth.

Cyclemys dhor shanensis is based on two specimens in which the hyo-hypoplastral hinge has not developed. The condition appears to be an individual variation rather than a geographical form; I have seen it also in examples from Siam.

8. **Cyclemys annamensis.**

Cyclemys annamensis Siebenrock, SB. Akad. Wiss. Wien. cxii, 1903, p. 341, pl. ii (type loc. Phuc-Son, Annam; Vienna Mus.), and Zool. Jahrb. Jena, Suppl. 10, 1909, p. 502.

Carapace depressed, tricarinate, the vertebral keel strong, the laterals fine and converging slightly at their ends; anterior margin of carapace reverted, posterior margin rounded, crenulated; nuchal shield moderate; first vertebral a little broader in front than behind; second to fourth vertebrals broader than long, broader than the costals. Plastron narrower than the opening of the shell, truncate anteriorly, notched posteriorly; the sutures between the abdominal, the pectoral and the humeral shields are the longest, and are almost of equal length. Bridge short but distinct, about two-fifths the length of the plastron, the hyo- and hypoplastral bones contributing in an equal degree to its formation; axillary and inguinal shields well developed, the former the larger.

Head moderate; snout shorter than the orbit, projecting slightly beyond the lower jaw; upper jaw emarginate mesially; skin of the hinder part of the head quite smooth; a strip of granular scales between the eye and the tympanum; digits fully webbed; limbs with transversely enlarged scales; tail half the length of the plastron.

Dark greyish-brown above, uniform; yellow below, each shield with a symmetrical dark brown patch. Head and neck dark brown above; a light stripe starting from the nostrils and passing through the eye backwards, widening slowly and bordered below with a dark stripe of about the same breadth; chin and neck below whitish; a dark band along the mandible and a few large dark spots on the chin; limbs dark brown with light longitudinal markings.

Length of shell 63, breadth 54, depth 25 mm.

Only known from the type-specimen, which, being juvenile, has the ossification of the shell very imperfect and the hyo-hypoplastral hinge not yet developed; it appears, however, to belong to the genus *Cyclemys*.

Genus CUORA.

Sternothœrus (not of Bell 1825) Wagler, Syst. Amphib. 1830, p. 137 (type *trifasciatus*).
Cuora Gray, Cat. Sh. Rept. 1855, p. 41 (type *amboinensis*).
Cistoclemmys Gray, Proc. Zool. Soc. London, 1863, p. 175 (type *flavomarginata*).
Cyclemys, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 128, and Fauna Brit. Ind. 1890, p. 28 (in part); Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 505 (in part).

Hexagonal neural plates short-sided behind. Plastron completely closing the shell, united to the carapace by ligamentous tissue; no distinct bridge; a distinct hinge between the hyo- and hypoplastral bones, both lobes being movable; entoplastron intersected by the humero-pectoral suture. Skull with a bony temporal arch (incomplete in *flavomarginata*); alveolar surfaces of jaws narrow. Digits strongly webbed. Tail moderate or short. Four species.

Range. Burma; Siam; French Indo-China; Southern China; the Malay Peninsula and Archipelago.

The Asiatic Box Tortoises form a small but distinct group, easily distinguished from *Cyclemys*, under which they are usually included by having a distinct hyo-hypoplastral hinge from birth and by the ability to move both halves of the plastron so that the shell can be entirely closed.

Key to the Species.

1. Plastron rounded posteriorly or feebly nicked; carapace distinctly convex.
   - Bony temporal arch complete; digits fully webbed; sole of foot with numerous small flat scales ..... *amboinensis*, p. 84.
   - Temporal arch incomplete posteriorly; digits not fully webbed; sole of foot with 6–8 large flat scales ..... *flavomarginata*, p. 86.
2. Plastron distinctly notched posteriorly; carapace depressed.
   - Carapace with three black streaks; head with a black temporal band enclosing light oval spots..... *trifasciata*, p. 87.
   - Carapace without longitudinal streaks; head olive, with two narrow yellow streaks on either side ..... *yunnanensis*, p. 88.

9. Cuora amboinensis. (Plate I, fig. 4.)

Testudo amboinensis Daudin, Hist. Nat. Rept. ii, 1802, p. 309 (type loc. I. of Amboyna).—*Kinosternon amboinense*, Bell, Zool. Journ. ii, 1825, p. 305.—*Cistudo amboinensis*, Gray, Ill. Ind. Zool. pt. 1, pl. vi, 1830 (=vol. i, pl. 77).—*Cuora amboinensis*, Günther, Rept. Brit. Ind. 1864, p. 12, pl. 4; Gray, Cat. Sh. Rept., Suppl. 1, 1870, p. 21, fig. (skull).—*Cyclemys amboinensis*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 133, and Fauna Brit. Ind. 1890, p. 31, fig. 10; Siebenrock, SB. Akad. Wiss. Wien, cxii, 1903, p. 243, and Zool. Jahrb. Jena, Suppl. 10, 1909, p. 503.

Emys couro Schweigger, Monogr. Chel. 1814, p. 46 (type loc. Java; Paris Mus. Nat. Hist.).
Terrapene bicolor Bell, Zool. Journ. ii, 1825, p. 484, pl. 16 (type from "America": Brit. Mus.).

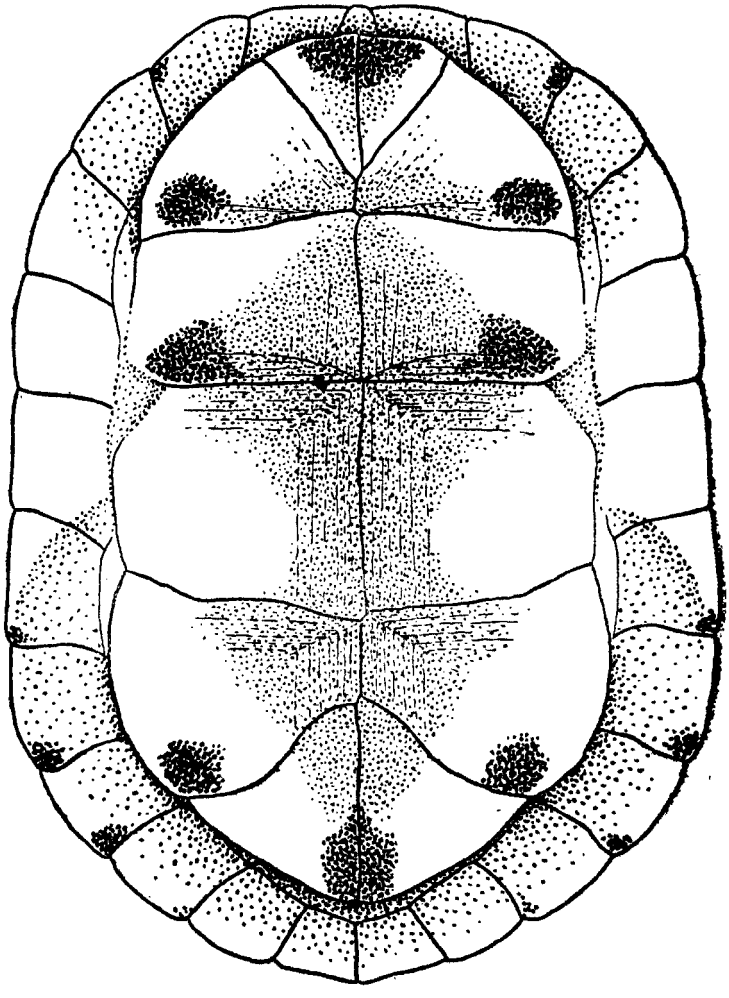

Fig. 16.—Shell of *Cuora amboinensis*, ventral view.

Carapace rounded and somewhat depressed, with a prominent obtuse vertebral and two fine lateral keels in the young, more elongate and very convex with only an indistinct vertebral keel in the adult, posterior margin not serrated.

Nuchal shield moderate or small; first vertebral broader behind than in front in the young, and usually the same in the adult; second and third vertebrals as long as broad or longer than broad, much narrower than the costals. Plastron as large as the opening of the shell (except in the very young), rounded anteriorly, rounded (sometimes just nicked) posteriorly; the longest median suture is between the abdominal shields, the shortest between the humeral or the femoral; no distinct bridge; axillary and inguinal shields small and elongate, or absent.

Head moderate, snout as long as the orbit, feebly projecting beyond the lower jaw; upper jaw feebly hooked. Skin of the hinder part of the head smooth, rarely divided into several large shields; digits fully webbed; limbs with transversely enlarged, subimbricate scales; sole of foot with many (40–50) small flat scales. Tail moderate or short.

Shell dark olive, brown, or almost black above; yellowish-white below with a black spot at the outer margin of each shield, or dark brown with the sutures between the shields yellow, rarely dark brown all over. In the young the plastral spots may be confluent, forming a median longitudinal patch. Head dark brown or green above, yellow below. A bright yellow band borders the top of the head, meeting its fellow above the nostril; a second paler one passes through the eye and is separated from the margin of the upper jaw by a dark band; a third borders the mandible. Limbs olivaceous or yellowish.

Length of shell 200, breadth 130, depth 90 mm.

Range. Tenasserim; Siam; Cambodia; Cochin China; the Malay Peninsula and Archipelago; the Philippine Islands.

The common Malayan Box-Tortoise inhabits the lowlands. It is found in ponds, marshes, and the rice-fields when flooded. It feeds entirely upon vegetable matter and is of a quiet timid disposition. When first caught and kept in captivity it is very shy, and will shut itself up in its shell directly it is touched. It is a somewhat dainty feeder and eats only small quantities at a time. Its eggs are few in number and large in size, 40–46 × 30–34 mm.

10. **Cuora flavomarginata.**

Cistudo trifasciata (in part), Gray, Cat. Tort. etc., Brit. Mus. 1844, p. 31.

Cistoclemmys flavomarginata Gray, Proc. Zool. Soc. 1863, p. 175 (type loc. China and Formosa; Brit. Mus.), and Cat. Sh. Rept., Suppl. 1, 1870, p. 20.—*Cuora flavomarginata*, Günther, Rept. Brit. Ind. 1864, p. 13, pl. 5.—*Cyclemys flavomarginata*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 135; Stejneger, Herpet. Japan, 1907, p. 503, pl. 33; Mell, Arch. Naturg. Berlin, 1922, Abt. A, Heft 10, p. 108.

Carapace convex, with a prominent, obtuse, vertebral keel in the young which may disappear entirely in old individuals;

posterior margin not serrated. Nuchal shield rather large, broadest behind; first vertebral narrower than the second; second to fourth vertebrals about as broad as long, narrower than the costals. Plastron as large as the opening of the shell (except in the very young), rounded anteriorly and posteriorly; the longest median suture is between the abdominal shields, the shortest between the humeral or the femoral; no distinct bridge; axillary and inguinal shields small or absent.

Head moderate; snout shorter than the orbit, truncate; upper jaw with a feeble hook; bony temporal arch incomplete posteriorly, some or all of the quadrato-jugal being absent. Skin of the hinder part of the head divided into shields. Fore-limbs with very large, subimbricate, transverse scales; sole of foot with 6–8 large flat scales; digits not quite fully webbed. Tail short.

Shell dark brown above, the centre of each shield being a lighter brown, the vertebral keel yellowish; dark brown below, the outer border of the plastron and the marginal shields being yellow. Top of the head olive-brown, yellow on the sides and below; a bright yellow streak edged with brown, narrow in front, broader behind, from the eye to the nape. Limbs olivaceous above, yellowish below.

Length of shell 180, breadth 120, depth 80 mm.

Range. Southern China as far south as the West River; Formosa; the Lu Chu Islands. Taylor is probably correct in not including it among the Philippine species (Philipp. J. Sc., Manila, xvi, 1920, p. 113).

Found in ponds and in flooded rice-fields.

There are three beautiful coloured sketches in the Reeves collection of drawings of the specimen presented by him to the British Museum (Natural History) and described by Gray as one of the types.

11. **Cuora trifasciata.**

Sternothœrus trifasciatus Bell, Zool. Journ. ii, 1825, p. 305, pl. xiv (type loc. unknown; Brit. Mus.).

Cistudo trifasciata, Gray, Ill. Ind. Zool. pts. xiii–xiv, pl. xii, 1834 (=vol. ii, pl. 61).—*Cyclemys trifasciata*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 133; Schmidt, Bull. Amer. Mus. Nat. Hist. N. York, liv, 1927, p. 405, fig. (head); Mell, Arch. Naturg. Berlin, 1922, Abt. A, Heft 10, p. 108.

Carapace somewhat depressed, with a prominent obtuse vertebral and two thin lateral keels in the young, which disappear almost entirely in the adult; posterior margin not serrated. Nuchal shield moderate, rarely absent; first vertebral broader in front than behind, as broad as or broader than the second; second to fourth vertebrals about as broad as long, narrower than the costals. Plastron as large as the

opening of the shell, rounded anteriorly, notched posteriorly; the longest median suture is between the abdominal shields or the pectoral, the shortest between the humeral; no distinct bridge; axillary and inguinal shields small or absent.

Head moderate, snout as long as the orbit, feebly projecting beyond the lower jaw; upper jaw feebly hooked; skin of the hinder part of the head smooth. Front of arm almost entirely covered with large transverse scales. Tail moderate or short.

Shell brown above with three black streaks along the keels; blackish below, with or without traces of radiating lines; the margin of the plastron and the marginal shields yellow. Head yellow above; a black streak passes along the side, including the eye and enclosing two oval yellow spots, the larger immediately behind the eye: a second thinner streak runs backwards from the lower jaw. Limbs brownish or yellowish, pinkish below. Soft parts pink in life.

Length of shell 170, breadth 128, depth 65 mm.

Range. Southern China (Kwang Si and Kwang Tung provinces; Hainan. Taylor is probably correct in not including it among the Philippine species (Philipp. J. Sc., Manila, xvi, 1920, p. 113).

12. **Cuora yunnanensis.** (Plate II, fig. 5.)

Cyclemys yunnanensis Boulenger, Ann. Mag. Nat. Hist. (7) xvii, 1906, p. 567 (type loc. Yunnan Fu and Tong Chuan Fu; Brit. Mus.).

Very closely allied to *C. trifasciata*, from which it differs in the shorter snout, in having no hook to the upper jaw, and very distinctly in coloration.

Shell olive-brownish above, reddish in the young, the shields sometimes with a narrow yellow margin. Greenish-yellow below, uniform or with a large reddish-brown patch on each plastral shield. Head and neck olive; a narrow yellow streak along the side of the head, passing through the eye and on to the neck; another below and parallel with it starting from the angle of the jaw; chin and throat yellow (orange in life) with olive markings; limbs with yellow spots and longitudinal streaks.

Length of shell 140, breadth 93, depth 55.

Only known from the type-specimens.

Genus **GEOEMYDA.**

Geoemyda Gray, Proc. Zool. Soc. 1834, p. 100 (type *Testudo spengleri*); Anderson, Zool. Res. W. Yunnan, 1879, p. 716; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 136, and Fauna Brit. Ind. 1890, p. 24 (in part); Stejneger, Proc. Biol. Soc. Washington, xv, 1902, p. 238; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 494 (in part); Annandale, Rec. Ind. Mus. ix, 1913, p. 64.

Geoemys Bonaparte, Chel. Tab. Anal. 1836, p. 6.
Nicoria Gray, Cat. Sh. Rept. i, 1855, p. 17 (type *Testudo spengleri*); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 118, and Fauna Brit. Ind. 1890, p. 26 (in part).
Melanochelys Gray, Proc. Zool. Soc. London, 1869, p. 187 (type *trijuga*).
Chaibassia Theobald, Cat. Rept. Brit. Ind. 1876, p. 6 (type *Geoemyda tricarinata* Blyth); Anderson, Zool. Res. W. Yunnan, 1878, p. 717.
Heoscmys Stejneger, Proc. Biol. Soc. Washington, xv, 1902, p. 238 (type *G. spinosa*); Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 506.
Clemmys, Lydekker, Palæont. Ind. 1885, (10) iii, pp. 170–178 (Siwalik Hills).

Second neural plate often octagonal, the succeeding ones short-sided behind. Plastron extensively united to carapace by suture, with short axillary and inguinal buttresses which reach to the outer margins of the costal plates. Entoplastron intersected by the humero-pectoral suture *. Skull with or without a bony temporal arch; alveolar surfaces of jaws narrow, without median ridge; choanæ on a level with the anterior part of the orbits. Skin of posterior part of head smooth or divided. Digits more or less webbed. Tail moderate or short.

Range. India to Japan and the Malay Archipelago; Central and South America. Seven species in Asia.

As shown by Annandale (1913) there is no clear line of demarcation between *Nicoria* and *Geoemyda*, as these genera were conceived by Boulenger and other authors. The former was stated to have a bony temporal arch, the latter none; in other characters they agreed with one another. For the three species included by Boulenger under *Geoemyda* (F. B. I. p. 24) this was undoubtedly correct, but for the many species placed under *Nicoria* it was not. A critical examination by Annandale of the species referred to *Nicoria* in the Indian Museum showed that the temporal arch was in every stage of devolution, and I can endorse his conclusions after examining the much larger material in the British Museum collection. It occurs in the American forms as well as in the Asiatic. The first stage in its disappearance is a thinning or a narrowing of the whole arch. The first bone to go is the quadrato-jugal; after that the postorbital and the jugal; in the most advanced stages only a small backward-pointing process composed of these two bones—the postorbital process—remains (see fig. 20).

The habits of the species are best shown in the characters of the feet, those with flattened feet and strongly webbed digits being chiefly aquatic, those with the hind feet more or less club-shaped and the digital webs short being chiefly terrestrial

* Not always in *G. trijuga edeniana*.

in their habits. All the species of *Geoemyda* are mainly, if not entirely, vegetarian in their diet.

Testudo scabra Linnæus has been referred by Boulenger, with doubt, to the synonymy of *Nicoria trijuga*. According to Lönnberg (Bihang Sven. Vet.-Akad. Handl. Stockholm, Bd. xxii, Afd. 4, 1896, p. 34) it is a species of *Geoemyda*, but "the specimen is quite young, dried and in a very bad condition," and cannot be identified with certainty.

The fossil species from the Siwaliks referred to *Clemmys* by Lydekker, namely *C. sivalensis* (Theobald), *C. hydraspica* Lydek., *C. theobaldi* Lydek., *C. punjabiensis* Lydek., and ? *C. trijuga* should in my opinion be placed under *Geoemyda*. They appear closely related to *G. trijuga*.

The following key, based chiefly upon external characters and disregarding their affinities, will serve to distinguish the Asiatic species now living :—

Key to the Species.

I. Tail moderate or long, with soft elongated spines at the base; a temporal arch.	
Carapace tricarinate, anterior margin serrated.	*spengleri*, p. 90.
II. Tail short, no elongated spines at the base.	
a. No bony temporal arch.	
1. Carapace tricarinate; upper jaw hooked	*sylvatica*, p. 94.
2. Carapace unicarinate; upper jaw notched.	
Anterior margin of shell serrated; second vertebral shield at least as broad as the second costal, much broader than long	*spinosa*, p. 91.
Anterior margin of shell not serrated; second vertebral narrower than second costal, not much broader than long; carapace much depressed	*depressa*, p. 95.
Anterior margin of shell not serrated; second vertebral narrower than second costal, not much broader than long; carapace arched.	*grandis*, p. 101.
b. A bony temporal arch; carapace tricarinate.	
Plastron dark brown or black, usually with a yellow border	*trijuga*, p. 96.
Plastron yellow.....	*tricarinata*, p. 95.

13. Geoemyda spengleri.

Testudo spengleri Gmelin, Syst. Nat. i, 1789, p. 1043 (no locality given).—*Geoemyda spengleri*, Gray, Proc. Zool. Soc. 1834, p. 100; Stejneger, Herpet. Japan, 1907, p. 501, pls. 31–32; Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 495.—*Nicoria spengleri*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 120.

Testudo serrata Shaw, Gen. Zool. iii, 1802, p. 51, pl. 9 (no locality given).

Testudo tricarinata Bory de St. Vincent, Voy. Iles d'Afriq. ii, 1804, p. 308, pl. 37.

Carapace considerably depressed, more arched in the adult than in the young, tricarinate, the vertebral keel prominent but obtuse, the lateral keels much thinner; anterior and posterior margins of carapace serrated, the latter very strongly, each marginal shield being reverted and acutely pointed. Nuchal shield large, broadest behind; vertebral shields broader than long, about as broad as the costal. Plastron nearly as long as the carapace, angulate laterally, openly emarginate anteriorly; hind lobe nearly as large as the shell-opening, about as long as the width of the bridge, notched posteriorly; the longest median suture is between the abdominal shields or the pectoral, the shortest between the gular. Axillary and inguinal shields present or absent.

Head moderate; snout shorter than the orbit, truncate. Upper jaw hooked. A thin but complete bony temporal arch. Skin of the hinder part of the head smooth. Front of arms with large, subimbricate, rounded or pointed scales; hind limbs more or less club-shaped, with enlarged horny scales, chiefly about the heel; hind part of thighs and base of tail with soft elongated spines. Digits half-webbed. Tail moderate, long in the young.

Shell light brown above, with traces of black markings following the lines of the keels; dark brown or black below, the margin of the plastron yellow. Head and limbs brownish; a yellow streak from behind the eye on to the neck, and yellow spots on the snout, tympanic region, and throat.

Length of shell 125, breadth 84, depth 50 mm.

Range. Southern China (Kwang Si and Kwang Tung provinces); Japan; Annam (Chang Nam province); the Malay Archipelago.

A rare species. There is a good coloured sketch of one in the Reeves collection of drawings. The remarkable resemblance which this species bears to *Cyclemys mouhoti* has already been commented upon.

14. Geoemyda spinosa.

Emys spinosa ex Bell, in Gray's Ill. Ind. Zool. pt. 1, pl. vi, 1830, and Syn. Rept. 1831, p. 20 (type loc. Penang; Brit. Mus.).—*Geoemyda spinosa*, Gray, Proc. Zool. Soc. 1834, p. 100, and Ill. Ind. Zool. vol. ii, pl. 57, 1835; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 137, and Fauna Brit. Ind. 1890, p. 35.—*Heosemys spinosa*, Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 506.

Carapace of adult much depressed, with broad, flattish, vertebral region and a prominent but obtuse keel; a small sharp spine at the posterior margin of each costal shield, corresponding to the position of the lateral keels, in all young and immature individuals. Anterior and posterior margins of carapace serrated and more or less reverted; carapace of

young more regularly arched, nearly as broad as long, its margin more strongly serrated, the posterior portion of each marginal shield being spinously produced, the spines sometimes bifid. Nuchal shield rather small; first vertebral broader than long, constricted anteriorly; second to fourth vertebrals much broader than long, at least as broad as the costals. Plastron nearly or quite as long as the carapace, angulate

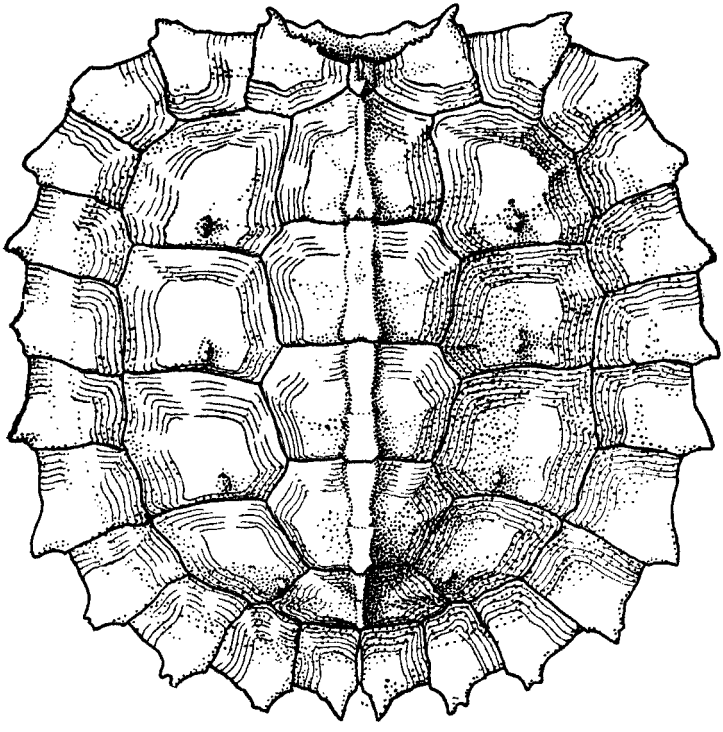

Fig. 17 A.—Shell of *Geoemyda spinosa*, from the type (juv.). Dorsal view.

laterally in the young, broadly emarginate anteriorly, the margins of the gular shields spinously produced, except in old individuals; hind lobe narrower than the opening of the shell, shorter than the width of the bridge, deeply notched posteriorly. The longest median suture is usually between the abdominal shields, the shortest between the anal; axillary shield usually larger than the inguinal. Head small, snout as long as or shorter than the orbit, truncate; upper jaw bicuspid. No

temporal arch. Skin of hinder part of the head smooth or partly divided into shields.

Fore-limbs with enlarged, subimbricate, horny scales, chiefly on the front; hind-limbs flattened in the young, becoming more club-shaped in the adult, with enlarged horny scales on the anterior and posterior margins, and flat, sometimes pointed scales, on the soles of the feet. Hinder part of thighs and base

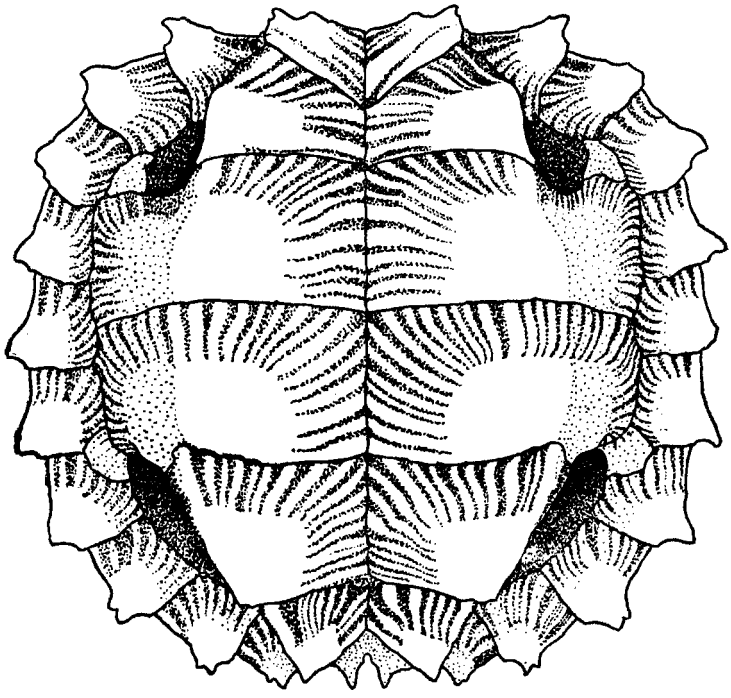

Fig. 17 B.—Shell of *Geoemyda spinosa*, from the type. Ventral view.

of tail with small conical tubercles. Fingers nearly half webbed, web of the toes shorter. Tail very short.

Shell brown above, reddish in the young, the vertebral keel lighter; yellowish below, the shields with dark radiating streaks. Head and limbs grey or brown; a yellow patch near the tympanum; neck with or without longitudinal yellow stripes; enlarged scales and tubercles on limbs yellow.

Length of shell 210, breadth 150, depth 77 mm.

Range. Tenasserim; Peninsular Siam ; the Malay Peninsula; Sumatra ; Borneo ; Natuna Islands.

The Spiny Hill-Tortoise is an inhabitant of mountain streams ; it feeds entirely upon vegetable matter.

15. **Geoemyda silvatica.**

Geoemyda silvatica Henderson, Rec. Ind. Mus. vii, 1912, p. 217 (type loc. near Kavalai, Cochin State Forests, S. India ; Ind. Mus.) ; Annandale, Rec. Ind. Mus. xi, 1915, p. 194.

Carapace considerably depressed, with prominent vertebral and thin lateral keels ; posterior margin feebly reverted, not serrated. Nuchal shield small ; first vertebral shield broader in front than behind, larger than the second, third, and fourth, which are considerably broader than long and as broad as the costals. Plastron large, nearly as large as the shell opening, angulate laterally, openly emarginate anteriorly and posteriorly ; the width of the bridge is less than the length of the hind lobe ; the longest median suture is between the abdominal shields, the shortest between the gular ; axillary and inguinal shields very small, one of the latter being absent.

Head rather large ; snout as long as the orbit, truncate ; upper jaw hooked ; mandibular symphysis very long, longer than the greatest diameter of the orbit. Skin of the hinder part of the head divided into moderately large shields.

Arms with enlarged, squarish or pointed, horny scales, chiefly on the front ; hind-limbs more or less club-shaped, the anterior margins and region of heels with enlarged horny scales. Fingers one-third webbed, toes with a rudiment only. Tail short.

Shell dark bronze above ; yellowish below, with two dark blotches on either side, upon the bridge. Front part of head above, and jaws, bright yellow in life, with a red spot on the top of the snout ; hinder part of head and neck brown. Limbs and tail black.

Length of shell 120, breadth 83, depth 45 mm.

The above is a description of the type specimen, a male. A second and less mature specimen is in the Madras Museum. Both were obtained in the dense forests of Cochin at an altitude of about 500 metres. According to the natives from whom Dr. Henderson obtained the type, the species inhabits short burrows underground and does not affect the neighbourhood of water. Both specimens were kept in captivity for six months, and Dr. Henderson remarks that they did not show any special partiality for water and when handled did not emit the offensive odour which *G. trijuga* does. They lived entirely upon vegetable food.

A coloured sketch of the living creature is in the Indian Museum.

16. Geoemyda depressa.

Geoemyda depressa Anderson, Ann. Mag. Nat. Hist. (4) xvi, 1875, p. 284, and Zool. Res. W. Yunnan, 1879, p. 721, pls. 55, 56, & 75 B (type loc. Akyab, near Arakan; Brit. Mus.); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 139, and Fauna Brit. Ind. 1890, p. 25.

Geoemyda arakana Theobald, Cat. Rept. Brit. Ind. 1876, Addenda, p. vii (type loc. Akyab); Anderson, Zool. Res. W. Yunnan, 1879, p. 718.

Carapace greatly depressed, with flattened vertebral region, which bears a prominent but obtuse keel, posterior margin serrated, anterior and posterior margins somewhat reverted. Nuchal shield moderate; first vertebral about as broad as long; second, third, and fourth broader than long, as broad as or narrower than the costals, mesially notched or concave along their posterior margins. Plastron nearly or quite as long as the carapace, truncate anteriorly; hind lobe narrower than the shell-opening, shorter than the width of the bridge, notched posteriorly; the longest median suture is between the abdominal shields, the shortest between the humeral or anal; axillary and inguinal shields present.

Head moderate; snout shorter than the orbit, truncate; upper jaw bicuspid. No bony temporal arch. Skin of the hinder part of the head divided into large shields. Arms with enlarged squarish or pointed horny scales, chiefly on the front; hind-limbs more or less flattened, unusually large in the adult male, the anterior margin and region of heel with enlarged horny scales. Fingers half-webbed, web of the toes shorter; claws very long and powerful. Tail short.

Shell light brown above, uniform or with dark mottlings; yellowish-brown below, the shields with dark blotches or broad rays. Soft parts (after Anderson): "head leaden, iris brown; neck and skin of limbs pale yellowish-brown. Large scales of limbs dark, almost black, with brownish margin."

Length of shell 242, breadth 172, depth 95 mm.

Range. Only known from the hills of Arakan.

17. Geoemyda tricarinata. (Plate II, fig. 1.)

Geoemyda tricarinata Blyth, J. Asiat. Soc. Bengal, xxiv, 1856, p. 714 (type loc. Chaibasa district, Chota Nagpur; Ind. Mus.); Theobald, Cat. Rept. Brit. Ind. 1876, p. 6; Anderson, Zool. Res. W. Yunnan, 1879, p. 718; Annandale, Rec. Ind. Mus. ix, 1913, pp. 66 & 73, and t. c. xi, 1915, pp. 194 & 347.—*Chaibassia tricarinata*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 139.—*Nicoria tricarinata*, Lydekker, J. Asiat. Soc. Bengal, lviii, 1889, p. 327, figs; Boulenger, Fauna Brit. Ind. 1890, p. 28.

Chaibassia theobaldi Anderson, Zool. Res. W. Yunnan, 1879, p. 718 (type loc. Bisnath Plain, N. Assam; Ind. Mus.); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 140, and Fauna Brit. Ind. 1890, p. 28.

Carapace elongate, markedly so in old males, strongly

arched, the sides descending more or less steeply in the adult, three obtuse keels, posterior margin of shell not or but feebly serrated. Nuchal shield moderate; first vertebral broader in front than behind; second, third, and fourth vertebrals broader than long, narrower than the costals. Plastron nearly as long as the carapace, feebly angulate laterally in the young, truncate anteriorly; hind lobe narrower than the shell-opening, longer than the width of the bridge, notched posteriorly; the longest median suture is between the abdominal shields or the pectoral, the shortest between the humeral or the femoral; axillary shield usually present, inguinal usually absent.

Head moderate; snout shorter than the orbit, truncate; upper jaw feebly notched mesially; temporal arch very slender and thin, sometimes incomplete. Skin of the hinder part of the head divided into large shields. Arms with enlarged squarish or pointed scales, chiefly in the front: hind-limbs more or less flattened, unusually large in the adult male, the anterior margins and region of heels with enlarged horny scales. Fingers half-webbed, toes with a rudiment only; claws long; tail short.

Shell dark plum-coloured above, the keels light brown; yellowish-brown below. Head and limbs dark plum or blackish above; a broad (red in life) stripe on each side of the head, starting from the nostril and passing above the eye and the tympanum; a similar band below the angle of the mouth, along the inferior margin of the lower jaw. Limbs with or without yellow spots.

I have examined eight specimens. Two of these were males, both very old individuals, and they had no yellow markings upon the head.

In one adult female the hyo-hypoplastral union is clearly visible externally, and the hypoplastron is attached to the carapace by ligamentous tissue. In two other individuals a similar condition is indicated, but is in a less advanced stage.

Length of shell 162, breadth 93, depth 67 mm.

Range. Chaibasa district, Chota Nagpur; Jalpaiguri district, N. Bengal; Daflas Hills and Bisnath Plain, N. Assam.

G. tricarinata is a hill species. Its habits appear to be almost entirely terrestrlal.

Geoemyda trijuga.

Five fairly well defined races are recognizable, dependent chiefly upon the coloration of the head and to a less extent that of the shell. The accompanying map shows their distribution. All the forms are chiefly aquatic in their habits and vegetarian in their diet.

18. **Geoemyda trijuga** (forma typica).

Emys trijuga Schweigger, Prodr. Monog. Chel. 1814, p. 41 (type loc. "Java"); Gray, Cat. Sh. Rept. i, 1855, p. 20, pl. 4 (shell).—*Melanochelys trijuga*, Gray, Proc. Zool. Soc. 1869, p. 187, fig. (skull).—*Nicoria trijuga*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 121, and Fauna Brit. Ind. 1890, p. 27.—*Geoemyda trijuga*, Annandale, Rec. Ind. Mus. ix, 1913, pp. 67, 71, pl. vi (head), and xi, 1915, p. 191.

Emys belangeri Lesson, in Belang. Voy. Ind. Or., Zool. 1834, p. 291, pl. 1 (type loc. Bengal; originally in Paris Mus. Nat. Hist.).

Emys trijuga var. *madraspatana* Anderson, Zool. Res. W. Yunnan, 1879, p. 729 (type loc. Madras).

Geoemyda trijuga subsp. *plumbea* Annandale, Rec. Ind. Mus. xi, 1915, p. 192 (type loc. Coorg, S. India; Ind. Mus.).

Clemmys theobaldi Lydekker, Palæont. Ind. (10) iii, 1885, p. 173, pl. xx (Siwalik Hills).

Carapace moderately depressed, tricarinate, the lateral margins more or less reverted, the posterior margin feebly

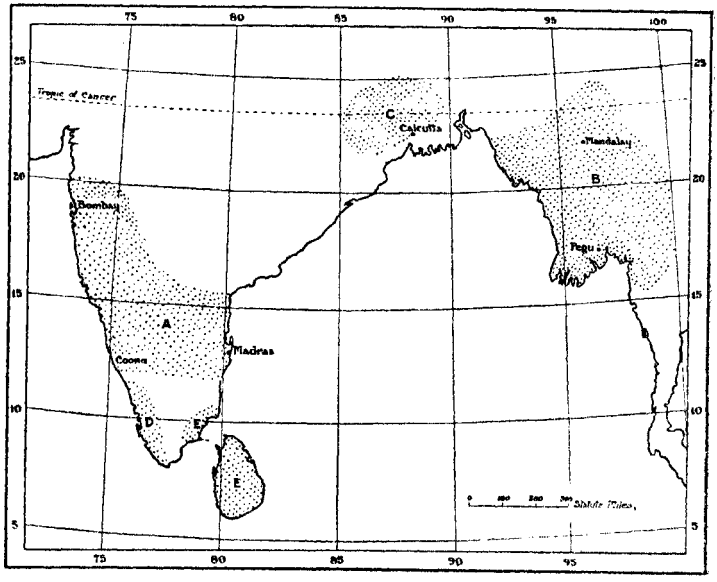

Fig. 18.—Map showing distribution of races of *Geoemyda trijuga*.

A. *Geoemyda trijuga* (forma typica).
B. *G. t. edeniana*.
C. *G. t. indopeninsularis*.
D. *G. t. coronata*.
E. *G. t. thermalis*.

serrated in the young. Nuchal moderate or small; vertebral shields somewhat variable both in shape and proportions, as long as broad or longer than broad in the adult, narrower

than the costals. Plastron nearly as long as the carapace, truncate or openly emarginate anteriorly ; hind lobe narrower than the shell-opening, usually shorter than the width of the bridge, deeply notched posteriorly ; the longest median suture is between the abdominal shields or the pectoral, the shortest usually between the humeral. Axillary and inguinal shields present, the latter sometimes very small.

Head moderate, snout shorter than the orbit, scarcely projecting beyond the lower jaw. Upper jaw mesially notched. A bony temporal arch, sometimes incomplete posteriorly. Skin of hinder part of head smooth or more or less divided into rather large shields. Limbs flattened ; front of arm and hinder part of leg with enlarged horny scales ; digits fully or nearly fully webbed. Tail very short.

Shell light brown in the young, dark brown to blackish in the adult, the plastron usually with a yellow margin which diminishes in width with age ; lateral keels sometimes yellow in the young. Head greyish or olivaceous with yellow or pink reticulations, best marked on the sides ; they become obscured with advancing age.

Length of shell 220, breadth 150, depth 80 mm.

Range. The Bombay and Madras Presidencies and the State of Mysore. I have seen specimens from Bombay, Poona, Goa, and Malabar on the western side of the Peninsula. According to Annandale (1913) the Madras Pond Tortoise is common in the east-central parts of the Madras Presidency, and is found at an altitude of at least 1000 metres on the Mysore plateau. The record from the Jhelum River in the Punjab needs confirmation. It has been recently introduced into Calcutta.

18 *a*. Geoemyda trijuga edeniana.

Melanochelys edeniana Theobald, Cat. Rept. Brit. Ind. 1876, p. 12 (type loc. Burma ; Ind. Mus.).—*Nicoria trijuga* var. *edeniana*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 123, and Fauna Brit. Ind. 1890, p. 28 ; Annandale, Rec. Ind. Mus. ix, 1913, pp. 69 & 71, pl. vi (skull), and xi, 1915, p. 191.

Emys trijuga var. *burmana* Anderson, Zool. Res. W. Yunnan, 1879, p. 723, pls. 67, 68 (type loc. Bhamo, Burma ; Ind. Mus.).

Nicoria trijuga Boulenger, Ann. Mus. Civ. Genova, (2) xiii, 1893, p. 312.

Shell dark brown in the young, black in the adult, the plastral margin and sometimes also the keels yellow. Head grey or brown, uniform or with indistinct yellowish reticulations which disappear at an early age. This race grows to a larger size than the typical one.

Length of shell 280, breadth 200, depth 115 mm.

Range. Burma ; recorded from Bhamo, the Arakan district, the Karenni foot-hills, Moulmein. Anderson (1879) states that

it is prevalent throughout the Irrawaddy and that it lays a number of oval eggs at one time, burying them a little way underground. It feeds on water-plants, more particularly on *Vallisneria*.

18 *b*. **Geoemyda trijuga indopeninsularis.**

Geoemyda indopeninsularis Annandale, Rec. Ind. Mus. ix, 1913, p. 71, pls. v & vi; ibid. xi, 1915, p. 347 (type loc. Singhbhum District, Chota Nagpur; Ind. Mus.).

Similar to *G. t. edeniana*, but grows still larger.

Length of shell 335, breadth 230, depth 145 mm.

Range. Chota Nagpur and Jalpaiguri District, N. Bengal.

Annandale has described this form as a distinct species. He states that the Hos, an aboriginal tribe of Chota Nagpur, from whom one of the types was obtained, consider it a land tortoise. I cannot find any good character, however, except that of size, to distinguish it from *G. t. edeniana*, but as its range appears to be quite distinct from that of *edeniana*, it may for the present be regarded as a geographical form. The specimen referred to by Annandale (1913, p. 72) from the Dharwar District, Bombay Presidency, I refer on geographical grounds to the typical form. The length of the shell is stated to be 284 mm. I have examined the head which is in the Museum of the Bombay Natural History Society, but the shell cannot now be found. The temporal arch in this race although extremely thin may be complete (specimen 17991, Ind. Mus.) or incomplete posteriorly, the very small quadratojugal being absent, as in one of the types.

18 *c*. **Geoemyda trijuga coronata.** (Plate I, fig. 5.)

Emys trijuga var. *coronata* Anderson, Zool. Res. W. Yunnan, 1879, p. 729 (type loc. Travancore).—*Geoemyda trijuga* var. *coronata*, Annandale, Rec. Ind. Mus. ix, 1913, pp. 68, 71, pl. vi (head); ibid. xi, 1915, pp. 192, 193.

Shell of the adult very dark brown or black. Top of the head and front of the snout black, temporal region yellow, the rest of the head olivaceous. The largest known shell is 175 mm. in length.

Range. Travancore and Cochin as far north as Calicut.

18 *d*. **Geoemyda trijuga thermalis.**

Emys thermalis Lesson, Cent. Zool. 1830, p. 86, pl. 29 (type loc. Ceylon).—*Nicoria trijuga* var. *thermalis*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 122, and Fauna Brit. Ind. 1890, p. 27; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 496.—*Geoemyda trijuga thermalis*, Annandale, Rec. Ind. Mus. ix, 1913, pp. 68, 71, pl. vi (head; ibid. xi, 1915, pp. 192,194; Deraniyagala, Ceylon J. Sc., Sect. B, xvi, 1930, p. 60.

Melanochelys scbœ Gray, Cat. Sh. Rept. i, 1870, p. 34 (type loc. Ceylon and India; Brit. Mus.).

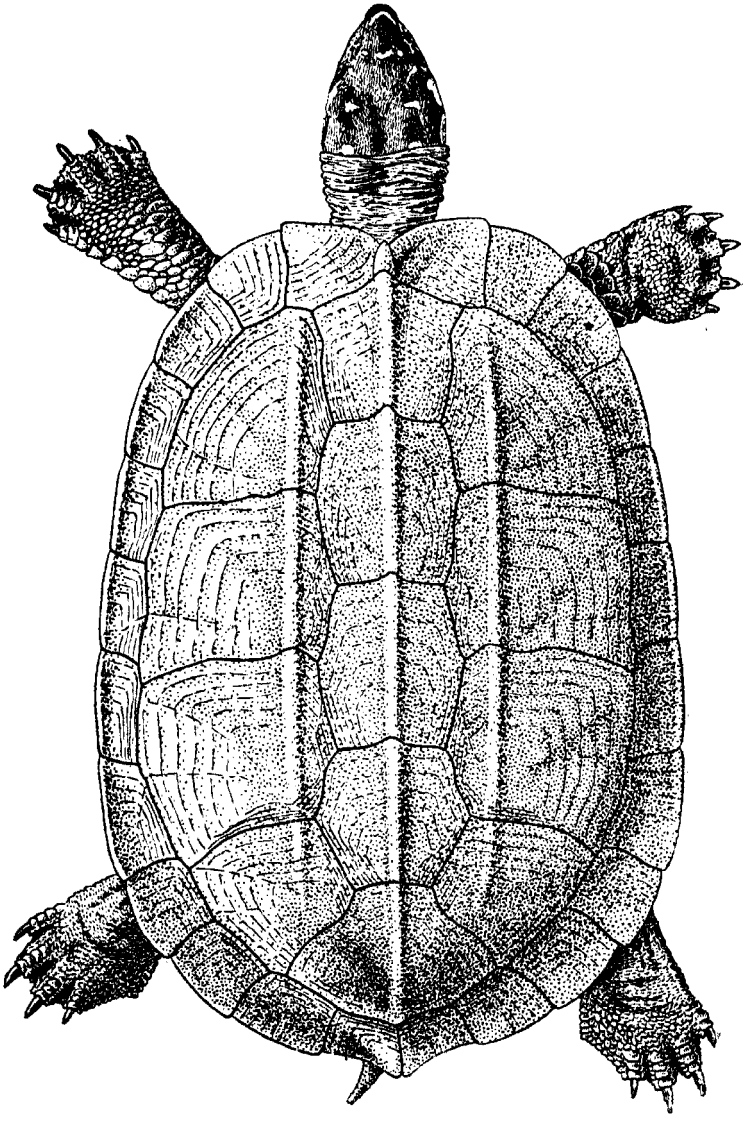

Fig. 19.—*Geoemyda trijuga thermalis*, dorsal view.

Shell of the young dark reddish-brown, of the adult black, the plastral margin and sometimes also the keels yellow. Head black with orange or red spots and reticulations all over, which more or less disappear with age.

Size as in the typical form.

Range. Ceylon and the adjacent part of the Indian Peninsula (Ramnad District); the Maldive Islands. It is common in ponds and ditches in Ceylon and has been taken in the Hot Springs at Kanniya (Eastern Province).

Annandale (1913) remarks that individuals exhibit remarkable variation in habits. They are abundant in ponds, sunning themselves on stones or logs that project from the water. If disturbed they dive immediately and swim along beneath the surface. At night they are frequently found in ditches and among wet grass. In the lake at Kandy they frequent the mouths of drains that open into the lake. Others are more terrestrial in their habits and may be found a long way from water. The stomachs of all those examined contained vegetable food only. Deraniyagala, on the other hand, states that it is omnivorous and is a very useful scavenger.

Four or five eggs are laid at a time. They measure 43–45 × 24–27 mm. in size and are buried in the earth at a depth of 7–8 cm.

19. **Geoemyda grandis.**

Geoemyda grandis Gray, Ann. Mag. Nat. Hist. (3) vi, 1860, p. 218; Günther, Rept. Brit. Ind. 1864, p. 19, pls. 1 & 2; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 138, and Fauna Brit. Ind. 1890, p. 25, figs. 7 & 8.

Heosemys grandis, Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 507.

Carapace arched or tectiform in the adult, not flattened on the vertebral region, considerably depressed in the young, in which it is nearly as broad as long; a strong but obtuse keel, very prominent in the young; posterior margin serrated and more or less reverted. Nuchal shield moderate; first vertebral usually longer than broad, constricted anteriorly in the adult; second, third, and fourth vertebrals about as long as broad, narrower than the costals, mesially notched or concave on their posterior margins. Plastron nearly or quite as long as the carapace, angulate laterally in the young, rounded in the adult, truncate or angularly emarginate anteriorly; hind lobe narrower than the shell-opening, shorter than the width of the bridge, deeply notched posteriorly; the longest median suture is between the abdominal shields, the shortest between the anal, humeral, or gular. Axillary and inguinal shields present.

Head moderate, snout as long as the orbit, feebly projecting beyond the lower jaw; upper jaw bicuspid. No bony temporal arch. Skin of the hinder part of the head more or less divided into large shields. Limbs flattened; front of arm and hinder part of legs with enlarged horny scales; digits fully or nearly fully webbed; tail very short.

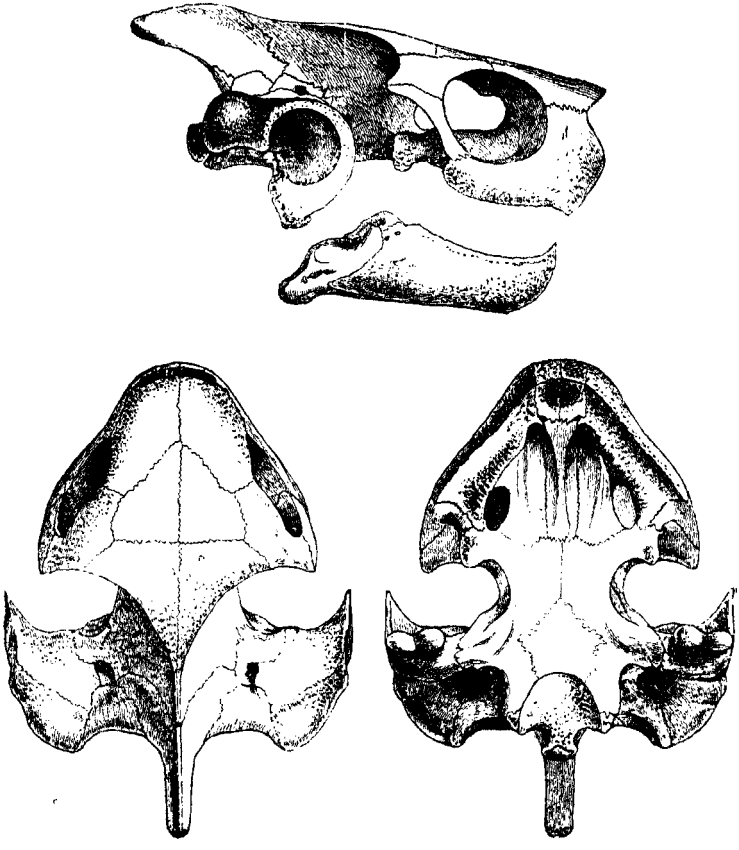

Fig. 20.—Skull of *Geoemyda grandis*. (After Boulenger.)

Shell dark brown above, the vertebral keel usually paler; yellowish or brownish below, the shields with dark brown markings which may almost entirely obscure the ground-colour, or with more or less distinct dark brown or black rays. Head and limbs greyish or greenish, the former with pink vermiculations, best marked upon the temporal region.

Length of shell 385, breadth 250, depth 140 mm.

A carapace in the British Museum collection, obtained by Major Stockley in the Me Wang Forest, Burmo-Siamese frontier, measures 435 mm. in length.

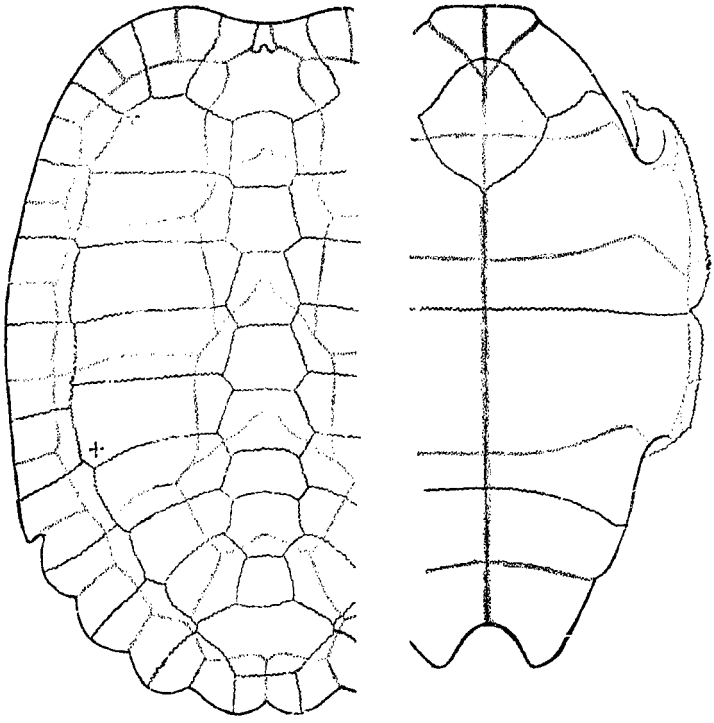

Fig. 21.—Shell of *Geoemyda grandis*. (After Boulenger.)
The + indicates the position to which the axillary and inguinal buttresses reach.

Range. Burma as far north as Pegu; Siam; Cambodia; the Malay Peninsula as far south as Province Wellsley.

Found both at sea-level and in the hills. One of the regular inhabitants of the Tortoise Temple in Bangkok.

Genus **DAMONIA**.

Damonia (in part) Gray, Proc. Zool. Soc. 1869, p. 193 (type *macrocephala*); (in part) Boulenger, Cat. Chel. Brit. Mus. 1889, p. 92.
Geoclemys, (in part) Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 476; (in part) Stejneger, Proc. Biol. Soc. Washington, xv, 1902, p. 237.

Second neural plate short-sided in front, the third octagonal, the fourth and fifth short-sided behind. Plastron extensively

united to carapace by suture, with strong axillary and inguinal buttresses, which extend to the outer extremities of the costal plates. Entoplastron anterior to the humero-pectoral suture. Skull with a bony temporal arch formed chiefly of the

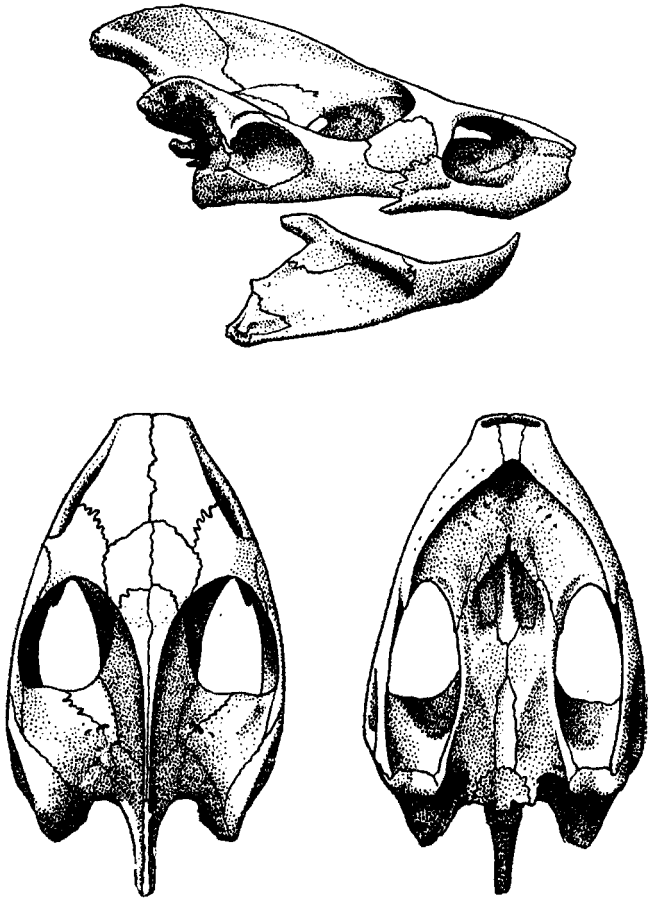

Fig. 22.—Skull of *Damonia subtrijuga*.

quadrato-jugal, which is in contact with the maxillary bone; jugal small, almost or completely excluded from the orbit. Alveolar surfaces of jaws very broad, without median ridge; bony choanæ on a level with the posterior margin of the orbit.

Skin of the hinder part of the head divided into small shields. Digits fully webbed. Tail very short. A single species.

The characters of the neural plates and of the temporal arch suffice, in my opinion, to separate this species generically from all the other Asiatic *Emydidæ*.

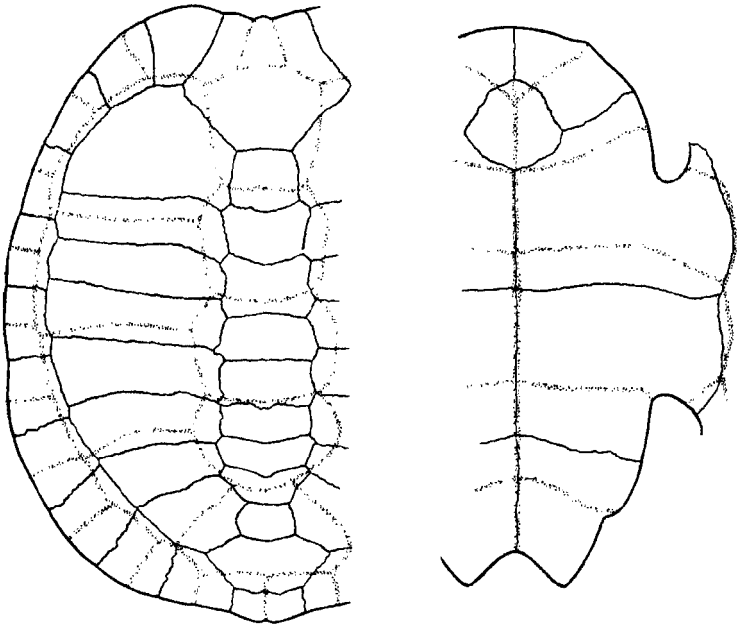

Fig. 23.—Shell of *Damonia subtrijuga*.

20. **Damonia subtrijuga.** (Plate I, fig. 3.)

Emys trijuga (not of Schweigg.) Schleg., Fauna Japon. Rept. 1833, p. 64 (type loc. Java ; Leiden Mus.).

Emys subtrijuga Schleg. & Müll. in Temm. Verh. Naturk. Ned. Ind., Rept. 1844, p. 30.—*Damonia subtrijuga*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 94 ; Flower, Proc. Zool. Soc. 1899, p. 610.—*Geoclemys subtrijuga*, Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 476.

Geoclemys macrocephala Gray, Proc. Zool. Soc. 1859, p. 479, pl. 21 (type loc. Siam ; Brit. Mus.).

Emys nuchalis Blyth, J. Asiat. Soc. Beng. xxxii, 1863, p. 82 (type loc. ? Java ; Ind. Mus.).

Damonia oblonga Gray, Ann. Mag. Nat. Hist. (4) viii, 1871, p. 367 (type loc. Batavia ; Brit. Mus.).

? *Damonia crassiceps* Gray, Cat. Sh. Rept., Suppl. 1870, p. 43 (type loc. "China" ; based on a sketch by Reeves).

Carapace tricarinate depressed, the lateral keels usually not extending beyond the third costal shield ; posterior border

of carapace not serrated. Nuchal shield moderately large; first vertebral longer than broad; second, third, and fourth usually broader than long, much narrower than the costals. Plastron nearly as long as the carapace, angulate laterally, truncate anteriorly; hind lobe narrower than the opening of the shell, as long as the width of the bridge, deeply notched posteriorly. The longest median suture is usually between the abdominal shields; axillary and inguinal shields large, subequal.

Head large; snout as long as the orbit, pointed and strongly projecting; upper jaw emarginate mesially; skin of the hinder part of the head divided into small shields. Digits fully webbed; limbs with large, broad, subimbricate scales. Tail very short.

Shell brown above, with lighter and darker markings; yellowish below, each shield with a large dark brown patch which may extend over nearly the whole of it. Soft parts dark brown, the top of the head chestnut; a yellow streak along the side of the head passing above the eye and the tympanum, another passing below the eye to the angle of the mouth; two or four vertical streaks below the nostrils; an angular yellow spot on each side of the chin; neck with longitudinal yellow streaks.

Length of shell 210, breadth 155, depth 95 mm.

Range. Siam (as far north as lat. 15° N.) to Cochin-China (Saigon) and the northern part of the Malay Peninsula; Java. Common in the vicinity of Bangkok.

Inhabits canals, slow-flowing rivers, and marshy places; of carnivorous habits, living chiefly upon molluscs and worms. Eggs large, 40–45 × 20–25 mm. in size.

Genus **HIEREMYS.**

Cyclemys, (in part) Boulenger, Fauna Malay Pen. Rept. 1912, p. 18.
Hieremys M. A. Smith, J. Nat. Hist. Soc. Siam, ii, 1916, p. 50 (type *annandalii*).

Second neural plate hexagonal, short-sided in front, or octagonal, the succeeding plates short-sided behind. Plastron extensively united to carapace by suture with short axillary and inguinal buttresses, which extend only to the outer margins of the costal plates; entoplastron intersected by the humero-pectoral suture.

Skull with bony temporal arch incomplete, most or all of the quadrato-jugal being absent. Alveolar surfaces of jaws broad, without median ridge; bony choanæ on a level with the middle of the orbits; skin of hinder part of head undivided. Digits fully webbed. Tail very short, not longer in the young than in the adult.

A single species.

21. Hieremys annandalei.

Cyclemys annandalii Boulenger, Fascic. Malay. Zool. i, 1903, p. 142, pls. 7 & 8 (type loc. Jalor, Patani; Brit. Mus.), and Fauna Malay Pen., Rept. 1912, p. 19, fig.—*Hieremys annandalii*, Smith, J. Nat. Hist. Soc. Siam, ii, 1916, p. 50.

Carapace unicarinate, depressed in the young, more elongate and more convex and with the keel less distinct in the adult;

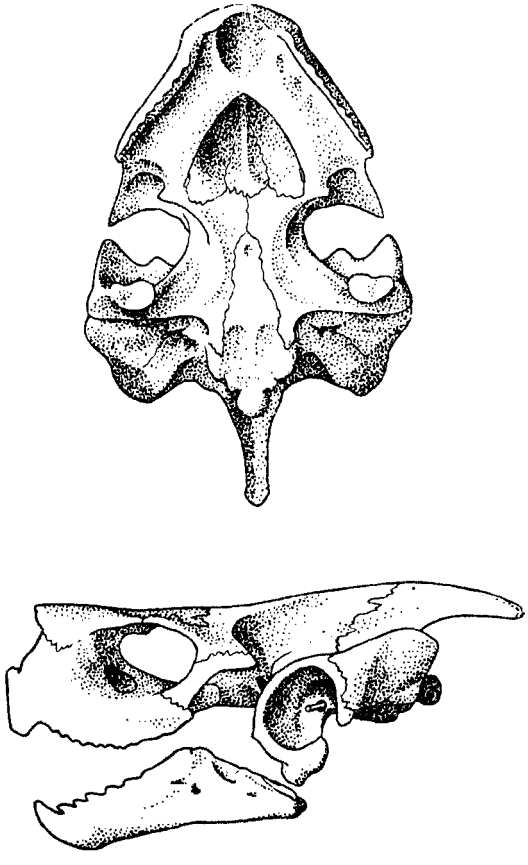

Fig. 24.—Skull of *Hieremys annandalei*.

posterior margin strongly serrated in the young, scarcely or not at all in the adult. Nuchal shield moderate, broadest behind. Five (rarely six) vertebral shields, the first four distinctly broader than long in the young, about as broad as long in the adult, narrower than the costals. Plastron nearly

as long as the carapace, angulate laterally in the young, not in the adult, truncate anteriorly ; hind lobe distinctly narrower than the opening of the shell, as long as or longer than the width of the bridge, deeply notched posteriorly ; the longest median suture is between the abdominal shields or the femoral, the shortest between the humeral ; axillary and inguinal shields large. Head moderate ; snout shorter than the orbit, scarcely projecting beyond the lower jaw ; margins of jaws

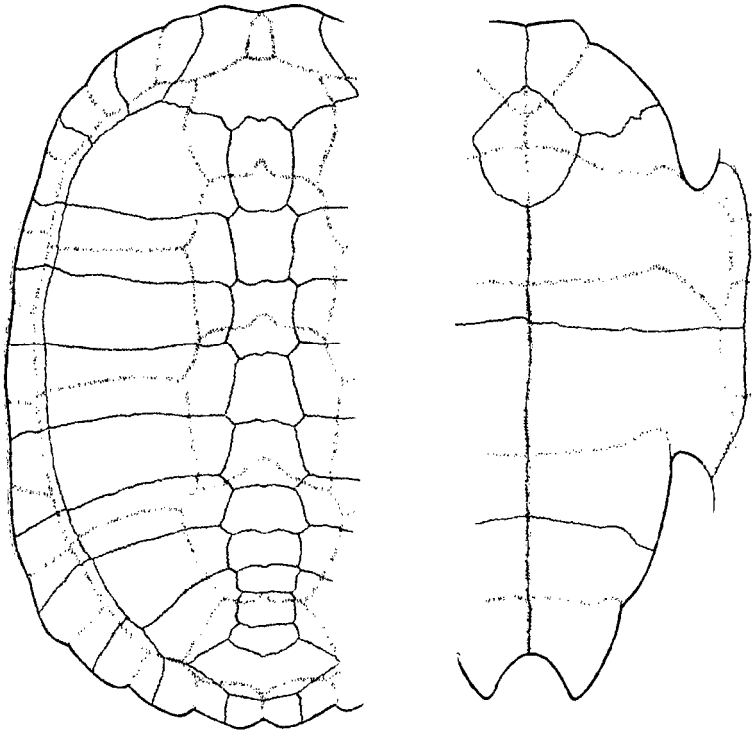

Fig. 25.—Shell of *Hieremys annandalei*.

strongly denticulated, the upper with a deep mesial notch and a smaller one on either side, with corresponding projections in the lower jaw. Skin of the hinder part of the head undivided. Limbs with broad band-like scales. Tail very short.

Shell very dark brown or black above, yellow below ; each plastral shield with a large black patch which may extend over

it entirely so that the whole shell is black. Soft parts greenish or greyish ; in the young a sinuous yellow stripe extends from the tip of the snout above the eye and tympanum on to the neck, with other parallel streaks upon the sides of the head and neck. In old individuals these streaks usually disappear, the head being greyish, with yellow or green vermiculations ; jaws greenish or yellowish.

Variation. Three examples out of 24 examined have six vertebral shields, the extra one being interposed between the fourth and fifth vertebrals.

Length of shell 450, breadth 280, depth 153 mm.

Range. Central Siam ; Cambodia ; the northern part of the Malay Peninsula.

Inhabits swamps and slow-flowing rivers, descending them as far as the sea. I have purchased many specimens said to have been caught in the fishing-stakes at the mouth of the Chao Phya River, near Bangkok ; Mr. Aagaard, of the Bangnara Rubber Estate, Patani, states that it is common in swampy fields in that neighbourhood, where it is kept by the Malays in captivity. I have obtained specimens from Kompong Sumbon on the Siamo-Cambodian frontier, and have seen a specimen in the Zoological Gardens at Saigon. In captivity it feeds upon water-plants, fruit, or almost any vegetable, and is easily tamed. Numbers of them are usually to be seen in the Tortoise Temple in Bangkok, an honour which they share with *Geoemyda grandis*, a species of much the same size and general external features. No particular form of worship is attached to these tortoises. They are presented to the temple in accordance with the tenets of the Buddhist religion, by which a life saved gains merit for the saver in the next world. Having saved the life of the tortoise the obligation ceases, and no particular care is taken of them in the temple afterwards.

Genus **NOTOCHELYS.**

Notochelys Gray, Proc. Zool. Soc. 1863, p. 177 (type *Emys platynota*) ; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 504.

Cyclemys, (in part) Boulenger, Cat. Chel. Brit. Mus. 1889, p. 129, and Fauna Brit. Ind. 1890, p. 28.

Hexagonal neural plates short-sided in front. Plastron with distinct bridge, united to carapace by ligamentous tissue ; an indistinct transverse hinge between the hyo- and hypoplastral bones ; entoplastron intersected by the humero-pectoral suture ; skull with complete or incomplete bony temporal arch, when incomplete due to loss of the quadrato-jugal and post-orbital ; alveolar surfaces of jaws narrow ; bony choanæ on a level with the front part of the orbits. Digits fully webbed. Tail short. A single species.

22. Notochelys platynota.

Emys platynota Gray, Proc. Zool. Soc. 1834, p. 54, and Illust. Ind. Zool. 1834, vol. ii, pl. 57 (type loc. Sumatra; Brit. Mus.).—*Cyclemys platynota*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 130, and Fauna Brit. Ind. 1890, p. 30; Flower, Proc. Zool. Soc. 1899, p. 612.—*Notochelys platynota*, Siebenrock, SB. Akad. Wiss. Wien, cxii, 1903, p. 344, and Zool. Jahrb. Jena, Suppl. 10, 1909, p. 504.

Cyclemys giebelii Hubrecht, Notes Leyden Mus. iii, 1881, p. 45 (type loc. Banka, Borneo; Leiden Mus.).

Carapace depressed, oval in the young, elongate and much flattened on the vertebral region in the adult, with an obtuse interrupted keel; anterior and posterior margins serrated in the young, only the latter in the adult; six, rarely seven, vertebral shields, which are much broader than long and narrower than the costals; the additional shield is smaller than the others and is intercalated between the fourth and fifth vertebrals. Plastron with distinct bridge, shorter than the carapace, distinctly narrower than the opening of the shell, truncate or openly emarginate anteriorly and posteriorly; the length of the hind lobe equals the width of the bridge; the longest median suture is between the abdominal shields or the pectoral, the shortest between the humeral or the femoral; axillary shield small or absent; a large inguinal shield.

Head moderate; snout as long as the orbit, projecting beyond the lower jaw; upper jaw bicuspid; skin of hinder part of head divided into small shields; digits fully webbed; front of arm and hinder part of leg with transversely enlarged scales, the other parts of the limbs, particularly the hind ones, being covered largely with small granular scales.

Shell brown or reddish-brown above, sometimes with fine radiating black lines; yellowish below, with a large dark brown or black spot on each shield, or almost entirely brown or black. Young often with a strong chestnut tinge, with two round black spots on each vertebral shield and one on each costal. Head and neck brownish or blackish with longitudinal yellow streaks, the two broadest being those behind the eyes. In the adult the markings are much fainter and may disappear.

Length of shell 320, breadth 230, depth 92 mm.

Range. Cochin-China; the Malay Peninsula as far north as lat. 9°; the Malay Archipelago. Siebenrock's record (1903) from Saigon is the only authentic one from the Indo-Chinese Region. The species was originally recorded from Tenasserim by Gray, but the record was shown to be erroneous later by Theobald (Proc. Asiat. Soc. Bengal, 1874, p. 82). The original error, however, has been perpetuated by later authors.

According to Flower this species lives in ponds and swampy

jungles. When alarmed it hisses after the manner of tortoises, and like many of them has the objectionable habit of voiding excrement when handled. After a time, however, when it gets used to being picked up, it ceases to do so. It feeds voraciously on almost any vegetable, but prefers fruit, of which it will get through a large quantity in a day. In captivity it quickly becomes tame.

Genus **GEOCLEMYS.**

Geoclemys (in part) Gray, Cat. Sh. Rept. i, 1855, p. 17 (type *hamiltonii*); (in part) Stejneger, Herpet. Japan, 1907, p. 496; (in part) Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 476.
Damonia, (in part) Boulenger, Cat. Chel. Brit. Mus. 1889, p. 92, and Fauna Brit. Ind. 1890, p. 34.

Hexagonal neural plates short-sided in front. Plastron extensively united to carapace by suture with strong axillary and inguinal buttresses which extend to the outer ends of the costal plates. Entoplastron anterior to the humero-pectoral suture. Skull with a bony temporal arch, the quadrato-jugal being separated from the post-orbital by the jugal. Alveolar surfaces of jaws very broad, without median ridge; bony choanæ on a level with the hinder part of the orbits. Skin of the hinder part of head divided into shields. Digits fully webbed. Tail very short, not longer in the young than in the adult. A single species.

23. **Geoclemys hamiltoni.** (Plate I, fig. 6.)

Emys hamiltoni Gray, Illus. Ind. Zool. pt. vi, pl. ix, 1831 (*guttata* on the plate), and Syn. Rept. 1831, pp. 21, 72 (type loc. India).—*Damonia hamiltoni*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 93, and Fauna Brit. Ind. 1890, p. 34; Parshad, Rec. Ind. Mus. x, 1914, p. 271.
Emys picquotii Lesson, Bull. Sc. Nat. xxv, 1831, p. 120 (type loc. ? Ganges).
Melanochelys pictus Murray, Ann. Mag. Nat. Hist. (5) xiv, 1884, p. 107 (type loc. Upper Sind; ? Karachi Mus.).
Clemmys palæindica Lydekker, Paleont. Ind. (10) iii, 1885, p. 178, pl. xxi.

Carapace tricarinate, strongly convex with three interrupted keels, or series of nodose prominences corresponding to the vertebral and costal keels; posterior border serrated in the young, less marked in the adult; nuchal shield moderate, broadest behind; first vertebral longer than broad; second and third vertebrals broader than long in the young, about as broad as long in the adult, narrower than the costals. Plastron nearly as long as the carapace, angulate laterally, truncate anteriorly; hind lobe narrower than the opening of the shell, as long as the width of the bridge, deeply notched

posteriorly; the longest median suture is between the abdominal shields or the femoral, the shortest between the anal or the humeral; axillary and inguinal shields large.

Head rather large, broad; snout as long as the orbit, rounded, slightly projecting beyond the lower jaw; the upper jaw broadly emarginate mesially. Skin of the hinder part of the head divided into large shields. Digits fully webbed; limbs with transversely enlarged scales. Tail very short, covered below with small granular scales.

Shell dark brown or black, elegantly marked with yellow spots and radiating streaks. Soft parts dark brown or black with rounded yellow spots, largest on the head and neck.

Length of shell 310, breadth 190, depth 125 mm.

Range. Northern India from Sind to Bengal. Precise data of locality are rare; it is said to be common in the Lower Ganges. Fossil in the Siwalik Hills.

Its habits are carnivorous.

Genus **SIEBENROCKIELLA.**

Bellia (not of Milne-Edwards, 1848) Gray, Proc. Zool. Soc. 1869. p. 197 (type *Emys crassicollis*); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 97, figs. 27, 28, and Fauna Brit. Ind. 1890, p. 32, fig. 11.
Siebenrockiella Lindholm, Zool. Anz. lxxxi (11/12), 1929, p. 280.

Hexagonal neural plates short-sided in front. Plastron extensively united to carapace by suture, with strong axillary and inguinal buttresses which extend to the outer extremities of the costal plates; entoplastron intersected by the humero-pectoral suture. Skull with a bony temporal arch, the quadrato-jugal being in contact with the jugal and post-orbital. Alveolar surfaces of jaws narrow, without median ridge; bony choanæ on a level with the anterior half of the orbits. Skin of the hinder part of the head divided into small shields. Digits fully webbed. Tail very short. A single species.

24. **Siebenrockiella crassicollis.** (Plate I, fig. 1.)

Emys crassicollis Gray, Illus. Ind. Zool. 1831, pl. 76, and Syn. Rept. 1831, p. 21 (type loc. Sumatra; Brit. Mus.); Günther, Rept. Brit. Ind. 1864, p. 28, pl. iv; Morice, Coup d'œil Fauna Cochinchine, Lyon, 1875, p. 63.—*Bellia crassicollis*, Gray, Proc. Zool. Soc. 1869, p. 197; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 98, and Fauna Brit. Ind. 1890, p. 32; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 478; Annandale, Rec. Ind. Mus. xi, 1915, p. 194.—*Siebenrockiella crassicollis*, Lindholm, Zool. Anz. lxxxi (11/12), 1929, p. 280.

Emys nigra Blyth, J. Asiat. Soc. Bengal, xxiv, 1855, p. 713 (type loc. Tenasserim; Brit. Mus.).

? *Pangshura cochinchinensis* Tirant, Rept. & Batr. Cochinchina, Saigon, 1885, p. 15.

Carapace depressed, tricarinate in the young, the lateral keels usually disappearing in the adult; posterior border serrated. Nuchal shield small, broadest behind; first vertebral elongate, much narrower behind than in front; second to fourth vertebrals as broad as long or a little broader than long, much narrower than the costals, narrowly in contact with each other in adults, the antero-lateral sides being convex, the postero-lateral straight or concave. Plastron smaller than the opening of the shell, strongly angulate laterally in

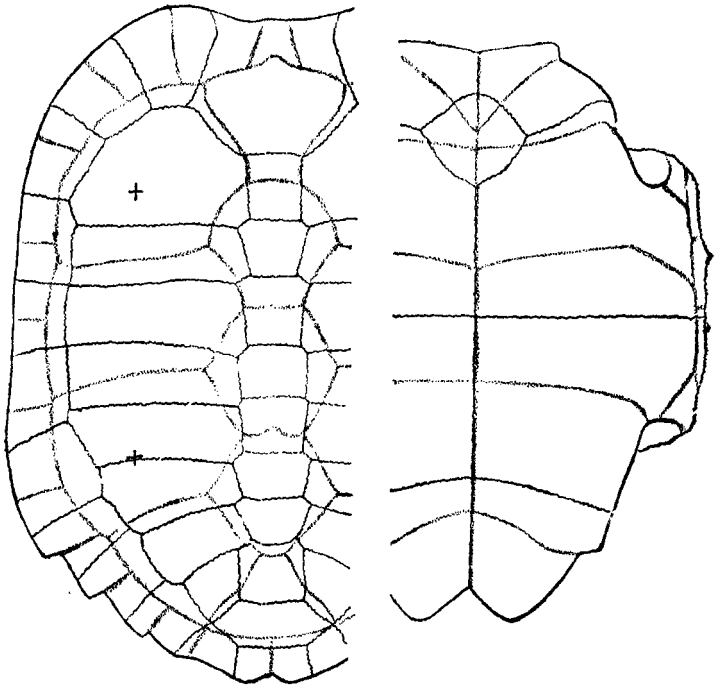

Fig. 26.—Shell of *Siebenrockiella crassicollis.* (After Boulenger.)

the young, truncate or emarginate anteriorly, deeply notched posteriorly; the width of the bridge exceeds the length of the hind lobe; the longest median suture is between the abdominal shields, rarely the pectoral; the suture between the humeral shields is much shorter than any of the others; axillary and inguinal shields large.

Head rather large, broad; snout shorter than the orbit, rounded, slightly projecting; upper jaw emarginate mesially; skin of the hinder part of the head and sometimes also of the crown irregularly divided; a strip of granular shields from the

eye to the tympanum; digits fully webbed; limbs with transversely enlarged subimbricate scales.

Shell black above or very dark brown; yellowish below, with black variegations or almost entirely black. Limbs dark greyish; head blackish, with large yellow spots in the young, those on the temple, over the eye, and at the angle of the jaw being usually constant; with age the markings grow less distinct and may disappaer.

Length of shell 170, breadth 130, depth 70 mm.

Range. Tenasserim; Siam; Cochin-China; the Malay Peninsula and Archipelago. It does not occur in India as shown by Annandale, and Taylor is probably correct in not including it in the Philippine fauna (Philipp. J. Science, Manila, xvi, 1920, p. 113).

The Black Pond Tortoise inhabits ponds, marshes, and sluggish streams. It is of carnivorous and voracious habits, feeding on shell-fish, worms, frogs, and animal offal. It is a common species in the great central plain of Siam.

Genus **CLEMMYS.**

Clemmys (in part) Ritgen, Nova Acta Ac. Leop.-Carol. xiv (i), 1828, p. 272 (type *Emys punctata=guttata*); (in part) Boulenger, Cat. Chel. Brit. Mus. 1889, p. 100; Stejneger, Herp. Japan, 1907, p. 492; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 479.
Sacalia Gray, Cat. Sh. Rept., Suppl. i, 1870, p. 35 (type *Emys bealei*).
Damonia, (in part) Boulenger, Cat. Chel. Brit. Mus. 1889, p. 92.

The above synonymy refers to Asiatic species only.

Hexagonal neural plates short-sided in front. Plastron extensively united to carapace by suture, with short axillary and inguinal buttresses which extend to the outer ends of the costal plates; entoplastron intersected by the humero-pectoral suture *. Skull with a bony temporal arch, the quadrato-jugal being in contact with the jugal and the post-orbital. Alveolar surfaces of jaws narrow; bony choanæ on a level with the anterior part of the orbits. Skin of the hinder part of the head smooth. Digits fully webbed. Tail moderate, longer in the young than in the adult.

Range. Southern Europe; N.W. Africa; Southern China and Japan.

Ten species, four of which occur in Eastern Asia; two are included in the present work.

Key to the Species.

Entoplastron anterior to the humero-pectoral suture; plastron notched behind; head with yellow streaks. *mutica*, p. 115.
Entoplastron intersected by the humero-pectoral suture; plastron emarginate behind; head with ocellate spots ..... *bealei*, p. 115.

* Except in *C. mutica*.

25. Clemmys mutica.

Emys muticus Cantor, Ann. Mag. Nat. Hist. ix, 1842, p. 482, and Zool. Chusan, 1842, pl. 7 (type loc. Chusan, China ; Brit. Mus.) ; Günther, Rept. Brit. Ind. 1864, p. 25.—*Damonia mutica*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 96.—*Clemmys mutica*, Siebenrock, Ann. Naturhist. Hofmus. Wien, xxiii, 1909, p. 312, pls. 12, 13 ; Schmidt, Bull. Amer. Mus. Nat. Hist. N. York, liv, 1927, pp. 404, 469.

Emys nigricans (in part) Gray, Cat. Sh. Rept. i, 1855, p. 20, pl. 15.

Clemmys schmackeri Boettger, Ber. senckenb. naturf. Ges. Frankfurt, 1894, p. 129, pl. 3 (type loc. ? Hainan ; Senckenb. Mus.).

Carapace depressed, tricarinate, the vertebral keel prominent, the laterals distinct in the young, scarcely or not apparent in the adult ; posterior margin feebly serrated. Nuchal shield small, broadest behind ; first vertebral much broader in front than behind ; second to fourth vertebrals broader than long or as broad as long, narrower than the costals. Plastron nearly as long as the carapace, feebly angulate laterally, truncate or broadly emarginate anteriorly ; hind lobe narrower than the shell-opening, as long as the width of the bridge, deeply notched posteriorly ; the suture between the abdominal shields is about as long as that between the femoral or the humeral, or the latter may be shorter ; the shortest suture is between the anal or the gular shields ; axillary and inguinal shields small.

Head rather small ; snout shorter than the orbit, slightly projecting beyond the lower jaw ; upper jaw slightly emarginate mesially. Skin of the hinder part of the head smooth ; a strip of granular scales between the eye and the tympanum. Limbs with transversely enlarged scales. Tail moderate.

Shell light brown above, the shields usually with black margins ; yellow below, each shield with a large blackish patch. Soft parts brown ; a yellow streak from behind the eye above the tympanum on to the neck.

Length of shell 150, breadth 115, depth 60 mm.

Range. Southern China ; Formosa ; Hainan.

A rare species in collections.

26. Clemmys bealei.

Cistudo bealei Gray, Syn. Rept. 1831, p. 71 (type loc. China ; Brit. Mus.).—*Emys bealii*, Gray, Proc. Zool. Soc. 1834, p. 54, and Cat. Sh. Rept. i, 1855, p. 21, pl. 8.—*Clemmys bealii*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 107 ; Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 482 ; Schmidt, Bull. Amer. Mus. Nat. Hist. N. York. liv, 1927, p. 403, fig.

Clemmys bealii var *quadriocellata* Siebenrock, SB. Akad. Wiss. Wien, cxii, 1903, p. 336, pl. 1 (type loc. Phuc-Son, N. Annam ; Vienna Mus. Nat. Hist.).

Carapace considerably depressed in the young, more convex in the adult, as broad as long in the young, elongate in the adult, tricarinate, the vertebral keel obtuse, the lateral keels

just indicated posteriorly or absent; posterior margin feebly serrated in the young, not in the adult. Nuchal shield longer than broad; vertebral shields broader than long, much broader than the costals in the young, as broad as the costals in the adult. Plastron nearly as long as the carapace, angulate laterally in the young, not in the adult, truncate anteriorly; hind lobe narrower than the opening of the shell, as long as the width of the bridge, openly notched posteriorly. The longest median suture is between the abdominal shields, the shortest between the humeral or the gular in the adult; axillary shield small, inguinal small or absent.

Head moderate; snout shorter than the orbit, truncate; upper jaw broadly emarginate mesially. Skin of the hinder part of the head smooth; a strip of granular scales between the eye and the tympanum. Front of fore-arm entirely or almost entirely covered with broad band-like scales. Digits fully webbed. Tail moderate.

Shell yellowish-brown above, speckled and lanceolated with black, or more or less uniform; yellowish below, spotted and marked with dark brown. Head brownish, uniform or speckled with black; occiput with two yellow ocelli with black centres on each side; neck with light longitudinal streaks (red in life).

Length of shell 143, breadth 92, depth 57 mm.

Range. Southern China as far north as Fukien; northern Annam; Hainan.

Reeves's original drawing upon which Gray's description was based shows only one pair of ocelli on the head. A close examination of the specimen from which the drawing was made, however, shows two ocelli on either side, the front ones being very faint. There are drawings of a second specimen in the same collection showing four ocelli, red longitudinal streaks upon the neck, and differences in the coloration of the shell. All specimens obtained in recent years have four ocelli.

Genus **CHINEMYS**, gen. nov.

Geoclemys (in part) Gray, Cat. Sh. Rept. i, 1855, p. 17; (in part) Stejneger, Herpet. Japan, 1907, p. 496; (in part) Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 476.
Damonia, (in part) Boulenger, Cat. Chel. Brit. Mus. 1889, p. 92.

Hexagonal neural plates short-sided in front. Plastron extensively united to carapace by suture, with strong axillary and inguinal buttresses which extend to the outer ends of the costal plates. Entoplastron intersected by the humero-pectoral suture. Skull with a bony temporal arch, the quadrato-jugal being in contact with the postorbital and the jugal. Alveolar surfaces of jaws broad, without median ridge; bony choanæ on a level with the posterior half of the

orbits. Skin of hind part of head divided into shields. Digits fully webbed. Tail moderate in the adult, long in the young. A single species.

On the character of the temporal arch, the length of the tail, and the position of the humero-pectoral suture I have separated this species from *Geoclemys*, with which it is usually associated.

27. **Chinemys reevesi.** (Plate II, fig. 3.)

Emys reevesii Gray, Syn. Rept. 1831, p. 73 (type loc. China ; Brit. Mus.).—*Geoclemys reevesii*, Gray, Cat. Sh. Rept. i, 1855, p. 18, pl. 5 ; Stejneger, Herpet. Japan, 1907, p. 497, pl. 30 & text-figs., and Proc. U.S. Nat. Mus. lxvi, 1925, p. 103 ; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 477 ; Werner, Denksch. Akad. Wiss. Wien, Bd. xcix, 1924, p. 40 ; Schmidt, Bull. Amer. Nat. Hist. N. York, liv, 1927, p. 470.—*Damonia reevesii*, Gray. Proc. Zool. Soc. 1869, p. 194, and Ann. Mag. Nat. Hist. (4) xi, 1873, p. 148 ; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 95 ; Mell, Arch. Naturg. Berlin, lxxxviii, 1922, pt. 10, p. 109.

Emys vulgaris picta Schlegel, Abbild. Amphib. 1840, p. 127*b*, pl. 42 (type loc. Japan ; Leiden Mus.).

Emys japonica Dumeril, Cat. Meth. Rept. i, 1851, p. 8 (type loc. Japan).

Damonia unicolor Gray, Ann. Mag. Nat. Hist. (4) xii, 1873, p. 78 (type loc. Ning-po, China ; Brit. Mus.) ; Sclater, Proc. Zool. Soc. 1873, p. 517, col. pl. 44.—*Geoclemys reevesii unicolor*, Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 477.

Geoclemys grangeri Schmidt, Bull. Amer. Mus. Nat. Hist. liv, 1927, p. 471, text-figs.

Carapace depressed, tricarinate, the lateral keels converging at their extremities ; posterior margin feebly serrated. Nuchal shield moderate, broadest behind ; first vertebral as long as or longer than broad, broader in front than behind ; second to fourth vertebrals broader than long, as broad as or narrower than the costals. Plastron nearly as long as the carapace, angulate laterally, truncate anteriorly ; hind lobe narrower than the opening of the shell, as long as the width of the bridge, strongly notched posteriorly ; the longest median suture is between the abdominal shields, the shortest between the humeral ; axillary and inguinal shields present, the former very variable in size.

Head moderate ; snout shorter than the orbit and projecting beyond the lower jaw ; upper jaw not or feebly emarginate mesially. Skin of the hinder part of the head divided into small shields. Digits fully webbed ; limbs with transversely enlarged scales. Tail moderate to long.

Shell brown above, the margins of the shields yellow ; yellowish below, each shield with a large dark brown blotch which may cover the whole plastron except at the sutures. Head greyish-olive ; the sides and the throat with yellow dark-edged longitudinal streaks and angular markings which

extend on to the neck; limbs grey, with or without yellow spots.

Length of shell 120, breadth 85, depth 55 mm.

Range. Yunnan; S.E. China to Japan. Mell (1922) states that it is brought into the Canton market in May. Werner (1924) records it from Yunnan Fu and Hongkong; Stejneger (1925) from Hongkong. Taylor doubts its occurrence in the Philippines (Philipp. J. Science, xvi, 1920, p. 113).

Damonia unicolor Gray is regarded by most herpetologists as a melanistic form of *reevesi*. It occurs independently of geographical distribution. In colour it varies from dark brown to almost black, the light markings on the head being usually absent.

Geoclemys paracaretta Chang, Contrib. Biol. Lab. Sc. Soc. China, v, 1929, p. 1, I refer to this species. A similar abnormality in the costal shields has been referred to under *Cyclemys mouhoti*, p. 79.

Genus OCADIA.

Ocadia Gray, Cat. Sh. Rept. i, 1870, p. 35 (type *sinensis*); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 85.

Hexagonal neural plates short-sided in front. Plastron extensively united to carapace by suture, with strong axillary and inguinal buttresses which extend nearly half-way along the costal plates; entoplastron intersected by the humero-pectoral suture. Skull with a bony temporal arch, the quadrato-jugal being in contact with the jugal and post-orbital. Alveolar surfaces of jaws broad, that of the upper with a median ridge; bony choanæ on a level with the middle of the orbits. Skin of hinder part of head undivided. Digits fully webbed. Tail moderate in the adult, long in the young. A single species.

28. Ocadia sinensis.

Emys sinensis Gray, Proc. Zool. Soc. 1834, p. 53, and Cat. Sh. Rept. i, 1855, p. 21, pl. 7 (type loc. S. China; Brit. Mus.).—*Ocadia sinensis*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 85; Stejneger, Herpet. Japan, 1907, p. 489, text-figs. & pl. 28; Siebenrock, SB. Akad. Wiss. Wien, cxii, Abt. 1, 1903, p. 334, and Zool. Jahrb. Jena, 1909, Suppl. 10, p. 470; Schmidt, Bull. Amer. Mus. Nat. Hist. N. York, liv, 1927, p. 402, fig.

Emys bennettii Gray, Cat. Tort., etc. 1844, p. 21, and Cat. Sh. Rept. i, 1855, p. 22, pl. 10 (type loc. Formosa; Brit. Mus.).

Emys chinensis Gray, Cat. Sh. Rept. i, 1870, p. 28.

Carapace moderately depressed, with three obtuse, interrupted keels in the young, the vertebral much the best marked, the laterals usually disappearing in the adult; posterior margin not serrated. Nuchal shield variable in size; first vertebral broader in front than behind; second and third vertebrals as broad as or broader than long, narrower than

the costals in the adult. Plastron nearly as large as the opening of the shell, truncate anteriorly, notched posteriorly; the width of the bridge slightly exceeds the length of the hind lobe; the longest median suture is between the abdominal shields, the shortest between the humeral; axillary and inguinal shields large. Head rather small, snout shorter than the orbit, slightly projecting beyond the lower jaw; upper jaw with a median notch. Skin of hinder part of head smooth. Limbs with transversely enlarged scales; digits fully webbed.

Shell olive-brown above, with or without a yellowish or reddish spot on each vertebral and costal shield, corresponding to the keels; yellow below, each shield with a large dark brown blotch, the pectorals and abdominals with two. Formosan specimens may have the plastron entirely yellow. Head and neck very dark olive, with numerous narrow, longitudinal, yellow lines, mostly upon the sides and below; similar lines and reticulations upon the limbs.

Length of shell 220, breadth 160, depth 90 mm.

Range. Southern China; Formosa; Hainan; Annam (Chang Nam Province).

A common species in Southern China; found in ponds, canals, and sluggish streams.

Genus **MORENIA.**

Morenia Gray, Cat. Sh. Rept. Suppl. i, 1870, p. 62 (type *Emys berdmorei* Blyth); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 66, and Fauna Brit. Ind. 1890, p. 35.

Hexagonal neural plates short-sided in front. Plastron extensively united to carapace by suture, with short axillary and inguinal buttresses which extend to the outer margins of the costal plates; entoplastron anterior to the humero-pectoral suture. Skull with a bony temporal arch, the quadrato-jugal being in contact with the jugal and postorbital; alveolar surfaces of jaws very broad, that of the upper with a strong median ridge; choanæ on a level with the posterior margin of the orbits; skin of the hinder part of the head transversely striated. Digits fully webbed. Tail short, not longer in the young than in the adult. Two species.

Range. Bengal and Southern Burma.

Aquatic and herbivorous.

Key to the Species.

Snout shorter than the orbit, scarcely projecting beyond the lower jaw; breadth of nuchal shield one-fourth that of the adjacent marginal ..... *ocellata*, p. 120.

Snout as long as the orbit, strongly projecting; breadth of nuchal shield one-half that of the adjacent marginal ..... *petersi*, p. 121.

29. Morenia ocellata. (Plate II, fig. 2.)

Emys ocellata Dum. & Bib., Erp. Gen. ii, 1835, p. 329, pl. 15 (type loc. "Bengal"; Paris Mus. Nat. Hist.).—*Batagur ocellata*, Gray, Proc. Zool. Soc. 1856, p. 182, pls. x, x *a*.—*Batagur* (*Morenia*) *ocellata*, Anderson, Zool. Res. W. Yunnan, 1879, p. 755, pls. 60 & 61.—*Morenia ocellata*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 66, and Fauna Brit. Ind. 1890, p. 35.

Emys berdmorei Blyth, J. Asiat. Soc. Beng. xxvii, 1858, p. 281.—*Batagur berdmorei*, Theobald, Cat. Rept. Asiat. Soc. Mus. 1868, p. 12, pl.

Carapace convex, less marked in the male than in the female, with an interrupted, nodose, vertebral keel in the young, which becomes less marked in the adult; posterior margin not serrated. Nuchal shield twice as long as broad in the adult; first vertebral subquadrangular, its lateral borders usually sinuous; second to fourth vertebral shields a little broader than long, rarely as broad as long in the adult, narrower than the costals. Plastron nearly as long as the carapace, angulate laterally, truncate anteriorly; hind lobe narrower than the opening of the shell, considerably shorter than the width of the bridge, notched posteriorly; the longest median suture is between the abdominal or the pectoral shields, the shortest between the gular or the femoral; axillary and inguinal shields large.

Head moderate, snout shorter than the orbit, slightly projecting beyond the lower jaw; upper jaw mesially notched; lower jaw flat below, with a large oval plate on either side near the angle of the mouth. Skin of the hinder part of the head transversely striated. Digits fully webbed; limbs with narrow band-like scales.

Shell light or dark olive-brown above, each vertebral and costal shield with a large, pale, yellow ocellus having a dark brown centre and less distinct dark border; with age these markings become less distinct; yellow below, uniform. Head and limbs olive or brownish; the former with pale yellow streaks, one from the tip of the snout passing above the eye on to the neck and another from behind the eye to above the tympanum being constant.

Length of shell, ♂ 155, ♀ 210, breadth, ♂ 110, ♀ 150, depth, ♂ 65, ♀ 95 mm.

Range. Southern Burma and Tenasserim (Toungoo to Mergui).

Very common in Pegu and Tenasserim. "Its habits are strictly aquatic, but it is often left dry by the drying up in the hot weather of the inundated plains, in which situations incredible numbers are captured for food by the Burmese, who fire the grass for the purpose" (*Theobald*).

30. Morenia petersi.

Emys ocellata (not of Dum. & Bib.) Blyth, J. Asiat. Soc. Bengal, xxvii, 1858, p. 281.—*Batagur ocellata*, Blyth, idem, xxxii, 1863, p. 82.

Batagur (*Morenia*) *petersi* Anderson, Anat. Zool. Res. W. Yunnan, 1879, p. 761, pl. 59 (type in Ind. Mus.).—*Morenia petersi*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 68, and Fauna Brit. Ind. 1890, p. 36; Annandale, J. & P. Asiat. Soc. Bengal (n. s.), ii, 1906, p. 205, pl. ii (fig. skull).

Carapace convex, with an interrupted, nodose, vertebral keel, best marked in the male; posterior margin not serrated. Nuchal shield large, longer than broad; first vertebral about as long as broad; second, third, and fourth vertebrals broader than long, narrower than the costals. Plastron nearly as long as the carapace, angulate laterally, truncate anteriorly; hind lobe narrower than the shell-opening, considerably shorter than the width of the bridge, notched posteriorly; the longest median suture is between the abdominal shields or the pectoral, the shortest between the femoral; axillary and inguinal shields large.

Head moderate; snout as long as the orbit, strongly projecting beyond the lower jaw; upper jaw mesially notched; a small oval plate on either side below the jaw at the angle of the mouth; skin of hinder part of head transversely striated. Limbs with narrow band-like scales; digits fully webbed.

Shell dark olive or black above, the vertebral and costal shields margined with pale green or yellow; first four vertebral shields with a narrow, pale green, longitudinal stripe and a U-shaped mark, the ends directed forwards; each costal shield and the last vertebral has a large pale green circle placed low down, with irregular looped lines of similar colour above; marginal shields with a pale green mesial streak. Yellow or orange below, the axillary shield and fourth, fifth, and sixth marginals with a dark centre. Top and sides of head very dark olive with three yellow streaks, one bordering the top of the head, one behind the eye, and one below it starting from the tip of the snout. Limbs bordered with yellow.

Length of shell, ♂ 125, ♀ 183, breadth, ♂ 85, ♀ 125, depth, ♂ 55, ♀ 82 mm.

Range. Bengal (Jessore District, Dacca, Fatehgarh); the specimens recorded from Calcutta were bought in the bazaar.

Blyth was the first to discover this species in Bengal. In 1859 he obtained two living specimens in the Calcutta bazaar, and being misled by the statement of Dumeril and Bibron that the types of *E. ocellata* came from Bengal, he re-named the Burmese species *E. berdmorei*. This led to much confusion of the names until it was finally put right by Anderson

(1879). It is now definitely established that the true *ocellata* is the Burmese species and that it did not come from Bengal, where *ocellata* is unknown.

Genus **HARDELLA**.

Hardella Gray, Cat. Sh. Rept., Suppl. i, 1870, p. 58 (type *Emys thurgii*); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 63, and Fauna Brit. Ind. 1890, p. 36.

Neural plates elongate, hexagonal, short-sided in front. Plastron extensively united to carapace by suture, with extremely developed axillary and inguinal buttresses which extend nearly to the neural plates, the former connected with the first rib; entoplastron anterior to the humero-pectoral suture. Skull with a bony temporal arch, the quadrato-jugal being in contact with the jugal and post-orbital; alveolar surfaces of jaws very broad with a strong median ridge; bony choanæ on a level with the posterior margin of the orbits; skin of the hinder part of head divided; digits fully webbed. Tail very short, not longer in the young than in the adult.

A single species.

31. **Hardella thurgi.** (Fig. Shell facing p. 50.)

Emys thurgii Gray, Syn. Rept. 1831, pp. 22, 72, and Illus. Ind. Zool. pt. 7, pl. 7, 1831=vol. i, pl. 73 (type loc. India; Brit. Mus.).—*Batagur thurgi*, Theobald, Cat. Rept. Brit. Ind. 1876, p. 23.—*Batagur* (*Hardella*) *thurgi*, Anderson, Zool. Res. W. Yunnan, 1878, p. 764.—*Hardella thurgi*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 63, figs. 18, 19, and Fauna Brit. Ind. 1890, p. 36; Chaudhuri, Rec. Ind. Mus. vii, 1912, p. 213.

Emys flavonigra Lesson, Bull. Sc. Nat. Paris, xxv, 1831, p. 120, and in Belanger's Voy. Ind.-Or., Zool. 1834, p. 293 (type loc. Ganges).

Kachuga oldhami Gray, Proc. Zool. Soc. 1869, p. 200, fig. 14 (type loc. India; Brit. Mus.).

Hardella indi Gray, Cat. Sh. Rept., Suppl. 1, 1870, p. 58 (type loc. Indus River; Brit. Mus.).

Batagur falconeri Lydekker, Paleont. Ind. (10) iii, 1885, p. 187, pls. xxiii, xxiv, xxv (Siwalik Hills, Pliocene).

Batagur cautleyi Lydekker, t. c. p. 194, pl. xxiv (Siwalik Hills; Pliocene).

Batagur watsonii Lydekker, Quart. J. Geol. Soc. xlii, 1886, p. 540, pl. xv (Piram I., G. of Cambay; Pliocene).

Carapace moderately depressed, unicarinate, the keel interrupted and produced into a knob at the hinder part of each vertebral shield; posterior margin feebly serrated. Nuchal shield moderate, broadest behind; first vertebral usually longer than broad and broader behind than in front; second to fourth vertebrals considerably broader than long in the young, about as broad as long and considerably narrower than the costals in the adult. Plastron nearly as long as the carapace, angulate laterally in the young, truncate anteriorly;

hind lobe much narrower than the opening of the shell, considerably shorter than the width of the bridge, notched posteriorly; the longest median suture is between the abdominal shields, the shortest between the gular; axillary and inguinal shields large.

Head moderate, snout a little shorter than the orbit, pointed and strongly projecting beyond the lower jaw; margins of jaws strongly denticulated, the upper biscupid; skin of hinder part of head divided by numerous transverse striæ; digits fully and broadly webbed; limbs with narrow transversely enlarged scales.

Shell dark brown above, the keel and the inner margins of the first three costals blackish, or entirely black; yellow below, with a large dark patch usually occupying the greater part of each shield, or entirely black. Head dark brown; a curved orange-yellow band on the top of the snout, another below the nostrils as far as the eyes, a third behind the eye passing on to the neck above the tympanum, a fourth along the ramus of the lower jaw. Limbs brownish, margined with yellow behind.

Length of shell 500, breadth 350, depth 205 mm.

Anderson states that males are much smaller (shell 170 mm. long) and also much rarer.

Range. The Gangetic and Brahmaputra river systems. The type of *Hardella indi*, a skull only, is said to have come from the Indus River.

According to Anderson, *H. thurgi* is a thoroughly aquatic tortoise, frequenting slow-flowing and stagnant waters. It feeds entirely upon vegetable matter and is quiet in disposition. Its flesh is excellent eating, and large numbers are brought into Calcutta during the cold weather and sold in the markets for food.

He gives an interesting account of how some of them are caught. "In the Purneah district, I have had an opportunity of observing at Kolassy a tribe of Tontals, who have been settled in the district for some generations, dive for this species in deep water, and perform the much more astonishing feat of capturing in the same way the very fierce *Trionyx gangeticus* and *T. hurum*. Ten of these men, all but naked, collected together, each man provided with a large bundle of green marsh grass, tied up as a cylinder, cut cleanly across at the ends. As they went into the water each thrust his bundle before him, which I soon perceived to be a float, on which each rested his chest, as he got beyond his depth. Then one after another, pushing away their floats, dived and reappeared, generally with an example of *Hardella thurgi* obtained in the mud at the bottom. Having caught a tortoise, the diver rests on his float to recover his breath, and coming slowly to shore, lands his captive, which he carries in two hands,

propelling himself with his feet. In this way they caught, in a very short time, about fifteen tortoises of the following species, viz., *Kachuga tectum*, *Emyda granosa*, and *Hardella thurgi*."

Genus KACHUGA.

Kachuga Gray, Proc. Zool. Soc. 1869, pp. 186, 200 (type *K. trilineata*); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 51, and Fauna Brit. Ind. 1890, p. 38.
Batagurella Gray, Proc. Zool. Soc. 1869, p. 200 (type *Kachuga peguensis*).
Dongoka Gray, idem, p. 202 (type *Kachuga hardwickii*).
Pangshura Gray, idem, p. 204 (type *Batagur tecta*).
Cuchoa Gray, Cat. Sh. Rept., Suppl. i, 1870, p. 61 (type *Batagur tentoria*).
Jerdonella Gray, idem, p. 61 (type *Pangshura sylhetensis*).
Emia Gray, idem, p. 61 (type *Batagur smithii*).

Neural plates hexagonal, short-sided in front. Plastron extensively united to carapace by suture, with extremely developed axillary and inguinal buttresses which extend nearly to the neural plates, the former connected with the first rib; entoplastron anterior to the humero-pectoral suture. Skull with a bony temporal arch, the quadrato-jugal being in contact with the jugal and the post-orbital; alveolar surfaces of jaws very broad, that of the upper jaw with a strong median ridge; bony choanæ on a level with the middle or hinder part of the orbits. Fourth vertebral shield much longer than broad, longer than the third, embracing four or five neural plates. Skin of the hinder part of the head divided into shields. Digits fully webbed. Tail short, not longer in the young than in the adult. Six species, all of which inhabit Northern India and Burma. Fossil in the Pleistocene of the Siwalik Hills and Narbada Valley.

All the species of this genus are thoroughly aquatic and herbivorous. The shells of the larger forms have a smooth unctuous surface and a broad postero-lateral flange to the carapace; their flesh is much esteemed as food.

Key to the Species.

A. Fourth vertebral shield pointed in front, narrowly in contact with the third, embracing five neural plates.
  1. 24 marginal shields; hinder margin of carapace not or but feebly serrated.
    Neural plates much longer than broad; third vertebral shield elongate, quadrangular (pentagonal in the young), with straight or nearly straight posterior border; its keel terminating in a rounded projection ..... [p. 125. *smithi*,
    Neural plates not much longer than broad; third vertebral shield pentagonal, pointed behind, its keel terminating in a backwardly projecting spine..... *tectum*, p. 126.
  2. 26 marginal shields; hinder margin of carapace strongly serrated ..... [p. 129. *sylhetensis*,

B. Third vertebral shield forming a broad suture with the fourth, which embraces four neural plates; neural plates much longer than broad.
  1. Second vertebral shield pointed and produced behind, entering the third; humero-pectoral suture straight ..... [p. 130. *dhongoka*,
  2. Second vertebral shield with straight transverse posterior border; humero-pectoral suture curved or forming an obtuse angle.
Alveolar surface of upper jaw very broad, the median ridge about mid-way between the outer and inner margins; choanæ behind the level of the eyes. (N.E. India.) ..... [p. 131. *kachuga*,
Alveolar surface of upper jaw broad, the median ridge nearer the inner than the outer margin; choanæ on a level with the middle of the eyes. (Burma.).. [p. 132. *trivittata*,

32. Kachuga smithi.

Batagur smithii Gray, Proc. Zool. Soc. 1863, p. 253 (type loc. Chenab River, Punjab; Brit. Mus.).—*Kachuga smithii*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 57, pl. 1, and Fauna Brit. Ind. 1890, p. 42; Chaudhuri, Rec. Ind. Mus. vii, 1912, p. 212; Parshad, idem, x, 1914, p. 269; Ingoldby, J. Bombay Nat. Hist. Soc. xxix, 1923, p. 120.
Kachuga sylhetensis Annandale, Rec. Ind. Mus. i, 1907, p. 171.

Carapace depressed, with obtuse, interrupted, vertebral keel; hind margin not or but feebly serrated. Nuchal shield moderate, broadest behind; first vertebral usually longer than broad in the adult, more or less constricted laterally; second vertebral shortest, broader than long, with straight or feebly curved posterior margin; third vertebral considerably longer than broad, pentagonal in the young, subquadrangular in the adult, its posterior border straight or slightly curved; fourth vertebral longest, tapering anteriorly and forming a narrow suture with the third; fifth vertebral much broader than long, broader than the others. Plastron nearly or quite as long as the carapace, strongly angulate laterally in the young, truncate anteriorly; hind lobe narrower than the shell-opening, notched posteriorly, shorter than the width of the bridge. The longest median suture is usually between the abdominal shields, the shortest between the gular; inguinal shields large, axillary smaller.

Head moderate, snout shorter than the orbit, pointed and strongly projecting beyond the lower jaw; upper jaw not notched mesially, with broad alveolar surface, its median ridge nearer the inner than the outer margin. Skin of the hinder part of the head divided into large shields. Digits fully webbed; limbs with transversely enlarged scales.

Shell pale olive above, the vertebral keel usually blackish; yellow below, each shield with a large dark brown patch covering the greater part of it. The colours of the soft parts

have not been adequately described ; specimens that I have examined do not show any particular markings.

Length of shell 230, breadth 155, depth 85 mm.

Range. The tributaries of the Indus, where it is not uncommon ; apparently much rarer in the Ganges watershed. Annandale records specimens from the Rajshahi District in Bengal.

According to Parshad it is omnivorous, but prefers flesh. Chaudhuri states that it lays five to eight eggs at a time, burying them in the sand.

Kachuga tectum.

Two races are recognized, distinguishable chiefly by the coloration of the soft parts :—

Second vertebral shield usually longer than the third ; top of head black, the temporal region yellow (orange) ; neck black, with fine yellow longitudinal lines ..... [p. 126. *K. tectum,*

Second vertebral shield usually shorter than third ; head olivaceous ; yellow streaks on neck indistinct or absent ..... [p. 128. *K. t. tentoria,*

33. **Kachuga tectum** (forma typica). (Plate II, fig. 6.)

Emys tectum Gray, Illus. Ind. Zool. pt. 2, pl. 7, 1830=vol. i, 1831, pl. 72, and (*tecta*) Syn. Rept. 1831, p. 23, pl. 5 (type loc. India) ; Bell, Monogr. Test. 1842, pl.—*Kachuga tectum*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 58, and Fauna Brit. Ind. 1890, p. 43 ; Annandale, Rec. Ind. Mus. viii, 1912, p. 38 ; Parshad, idem, x, 1914, p. 270.

Emys trigibbosa Lesson, Bull. Sc. Nat. xxv, 1831, p. 120, and in Belang., Voy. Ind.-Or., Rept. 1834, p. 29.

Pangshura flaviventer Günther, Rept. Brit. Ind. 1864, p. 35, fig. (type loc. India ; Brit. Mus.).

Pangshura ventricosa Gray, Cat. Sh. Rept., Suppl. i, 1870, p. 60 (type loc. India, ? Assam ; Brit. Mus.).

Carapace elevated, subtriangular in transverse section in the young, more rounded in the adult, with a prominent vertebral keel which is produced into a strong spinous process at the posterior margin of the third shield ; hinder margin of carapace not or feebly serrated. Nuchal shield usually broadest behind ; first vertebral variable in shape, usually with straight lateral borders diverging forwards in young and half-grown specimens, narrower in front and with sinuous lateral borders in adults ; second vertebral usually longer than the third, obtusely pointed behind ; third vertebral pointed behind, its tip touching the pointed extremity of the fourth, which is much longer than the other vertebral shields ; fifth vertebral broader than long, broader than the others. Plastron nearly or quite as long as the carapace, angulate laterally, truncate anteriorly ; hind lobe smaller than the shell-opening, notched posteriorly, as long as or a little shorter

than the width of the bridge; the longest median suture is between the abdominal shields or the femoral, the shortest between the gular or the anal; axillary and inguinal shields subequal, or the latter the larger.

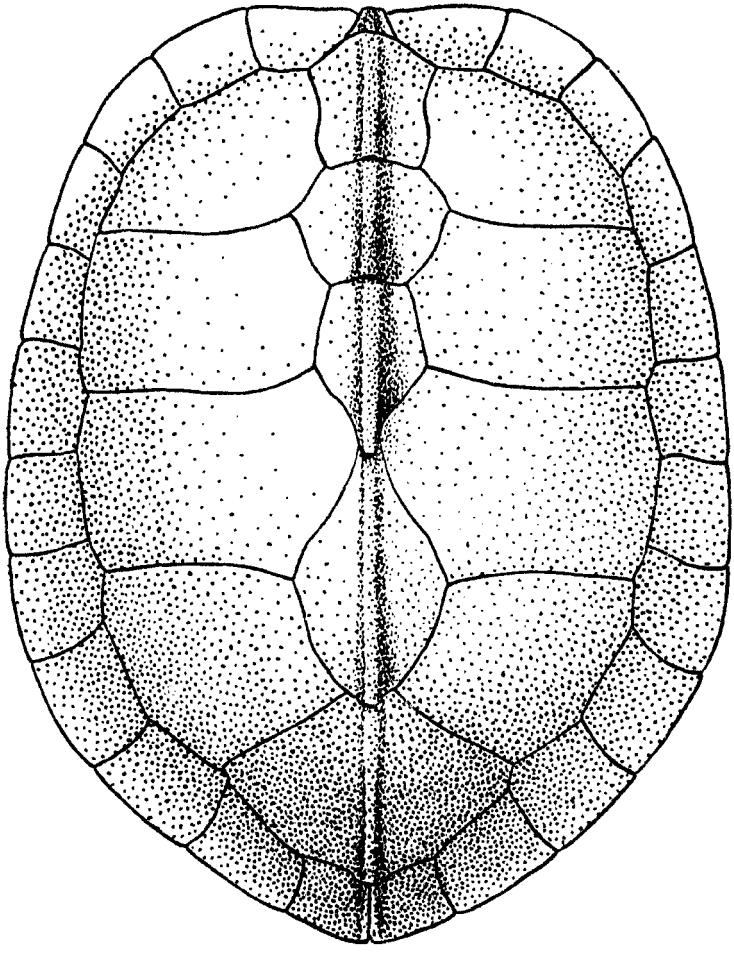

Fig. 27.—Shell of *Kachuga tectum*, dorsal view.
(The second vertebral shield is not correctly drawn.)

Head moderate; snout shorter than the orbit, pointed and slightly projecting beyond the lower jaw; upper jaw not notched; alveolar surface broad, the median ridge upon it nearer to the inner than the outer margin. Skin of the hir

part of the head divided into rather large shields; digits fully and broadly webbed; limbs with transversely enlarged scales.

Shell olive above in the young, with small black dots and an orange or red vertebral stripe, most conspicuous on the first three shields; with age the shell gets darker and the markings are less conspicuous; reddish or yellowish below, with large dark brown or black spots; rarely uniform (*P. flaviventer*). Top of the head black; temporal regions orange or yellow, this colour often uniting behind to form a V-shaped mark; neck blackish, with fine yellow longitudinal lines: limbs dark olive, bordered and spotted with yellow; back of thighs yellow, with dark transverse bars.

Length of shell 230, breadth 170, depth 105 mm.

Range. Northern India—the Ganges, Brahmaputra, and Indus river systems. The exact limits of its range are not clearly defined. Fossil in the Pleistocene of the Siwalik Hills.

Parshad states that it feeds on vegetable matter and is very active in its movements.

33 *a*. **Kachuga tectum tentoria.**

Emys tentoria Gray, Proc. Zool. Soc. 1834, p. 54 (type loc. Dhond, Poona Dist.; Brit. Mus.).—*Pangshura tentoria*, Günther, Rept. Brit. Ind. 1864, p. 34, pl. 4.

Pangshura dura Gray, idem, 1869, p. 205, and Cat. Sh. Rept. Suppl. i, 1870, p. 61 (apparently same type as for *Emys tentoria*).

Emys (*Pangshura*) *tectum* var. *intermedia* Blandford, J. Asiat. Soc. Bengal, xxxix, 1870, p. 339, pl. 14 (type loc. Hasdo River, Bilaspur, Central Provinces; Ind. Mus.), and xlviii, 1879, p. 110.

Kachuga intermedia Boulenger, Cat. Chel. Brit. Mus. 1889, p. 58, and Fauna Brit. Ind. 1890, p. 43.—*Kachuga tectum intermedia*, Annandale, vii. 1912, p. 265.

Pangshura leithii Gray, Cat. Sh. Rept., Suppl. i, 1870, p. 60 (type loc. Poona; Brit. Mus.).

Differs from the typical form in having the second vertebral shield usually shorter than the third, and in coloration. The carapace is paler than in the typical form; the head is dull olive and the red or orange patches on the temporal region are almost or entirely absent; there is a conspicuous red patch behind the tympanum; the neck is olivaceous and the yellow streaks, if present, are fewer and less distinct. The limbs are without yellow spots, and the dark transverse bars at the back of the thighs are more numerous than in the typical form. Size as in the typical form.

Range. The Mahanadi and Godavari and probably the Kistna river systems. Very common at Cuttack and Sambalpur according to Annandale.

Blanford (1879) states that the natives will not eat the flesh of this species as they say it makes them ill.

Annandale, who has examined numbers of this race as well as of the typical one, states that the proportions of the second vertebral shield are variable, but that the coloration of the soft parts is constant.

The type of *E. tentoria* was collected by Colonel Sykes in the Poona District, and an excellent coloured sketch by him of a specimen from this district is in his collection of drawings (Book 8, No. 226) in the British Museum (Natural History). Its coloration is that of the southern race, and the name *tentoria* therefore has priority over *intermedia*.

34. **Kachuga sylhetensis.** (Plate II, fig. 4.)

Pangshura sylhetensis Jerdon, Proc. Asiat. Soc. Bengal, 1870, p. 69 (type loc. Khasi Hills, Assam; Brit. Mus.).—*Jerdonella sylhetensis*, Gray Cat. Sh. Rept., Suppl. i, 1870, p. 61.—*Kachuga sylhetensis*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 57, and Fauna Brit. Ind. 1890, p. 42.

Carapace elevated, subtriangular in transverse section, with a strong vertebral keel which is produced into a very strong backwardly projecting spike at the posterior margin of the third shield; hinder margin very strongly serrated. Nuchal shield moderate; first vertebral broader in front than behind in the young, equally broad in front and behind in the adult; second vertebral shortest, broader than long, with straight or feebly curved posterior border; third considerably longer than broad, obtusely pointed behind, its tip touching the pointed extremity of the fourth, which is much longer than any of the others; fifth shield longer than broad, obtusely pointed behind; 26 marginal shields, the extra pair being formed by the division of the supracaudal shields.

Plastron about as long as the carapace, angulate laterally, truncate anteriorly; hind lobe smaller than the shell-opening, openly notched posteriorly, its length slightly less than the width of the bridge; the longest median suture is between the abdominal shields or the femoral, the shortest between the gular; axillary and inguinal shields large.

Head moderate; snout shorter than the orbit, pointed and strongly projecting beyond the lower jaw; upper jaw hooked. Skin of hinder part of head feebly divided. Digits fully and broadly webbed; limbs with transversely enlarged scales.

Shell olive-brown above, the vertebral keel paler; yellow below, each shield with a large dark brown spot. Head and limbs brown; a yellow sinuous transverse stripe across the back of the head; another similarly coloured along the lower jaw; neck with light longitudinal streaks.

Length of shell 180, breadth 142, depth 78 mm.

Range. Assam (the Garo, Khasi, and Naga Hills).

35. Kachuga dhongoka.

Emys dhongoka Gray, Illus. Ind. Zool. ii, 1834, pl. 60 (type loc. N. India).—*Batagur dhongoka* (in part), Gray, Cat. Sh. Rept. 1855, p. 36, pls. 18 & 36; Theobald, Cat. Rept. Brit. Ind. 1876, p. 22.—*Kachuga dhongoka*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 56, and Fauna Brit. Ind. 1890, p. 41; Chaudhuri, Rec. Ind. Mus. vii, 1912, p. 212.

Emys duvauceli Dum. & Bib., Erp. Gen. ii, 1835, p. 335 (type loc. Bengal; Paris Mus. Nat. Hist.).—*Batagur duvaucelii*, Anderson, Zool. Res. W. Yunnan, 1879, p. 738.

Kachuga hardwickii Gray, Proc. Zool. Soc. 1869, p. 212 (subst. name for *Batagur dhongoka*, 1855).

Batagur durandi Lydekker, Paleont. Ind. (10) iii, 1885, p. 192, pl. xxiv.

Carapace depressed, unicarinate, the keel interrupted, most prominent upon the second and third vertebral shields, where it terminates in a pointed knob in the young, which becomes less marked with advancing age; posterior margin feebly crenulated. Nuchal shield moderate, broadest behind; first vertebral longer than broad, more or less constricted in the middle; second broader than long in the young, longer than broad in the adult, narrowing posteriorly, its posterior margin produced and fitting into an emargination of the third shield, which is shorter than the second or fourth; fourth shield usually the longest, forming a broad suture with the third. Plastron long and narrow, considerably narrower than the opening of the shell, angulate laterally in the young, truncate anteriorly, notched posteriorly; the width of the bridge considerably exceeds the length of the posterior lobe. The longest median suture is between the abdominal shields, the shortest between the gular; humero-pectoral suture straight; inguinal shield large, axillary smaller.

Head moderate; snout shorter than the orbit, pointed and projecting beyond the lower jaw; upper jaw feebly bicuspid; alveolar surfaces of jaws broad, the median ridge on the upper nearer to the inner than the outer margin; skin of hinder part of the head divided into shields by fine lines; digits fully and broadly webbed; limbs with transversely enlarged scales.

Shell olive or brownish above, with a black vertebral and two lateral stripes, not so distinct as in *trivittata*, but present in both sexes; yellowish below, the young usually with a large reddish-brown patch on each shield. Soft parts olivaceous or yellowish; a yellow stripe along the side of the head starting from the nostrils and passing above the eye and the tympanum.

Length of shell 400, breadth 340, depth 140 mm. Males are said not to exceed 260 mm. in length of shell.

Range. N.E. India; the Ganges as far west as Allahabad and north to Nepal. Anderson states that it has been found in the Brahmaputra in Assam. Fossil in the Siwalik Hills.

Eggs rather elongate, 55×33 mm. in size; 30 to 35 are deposited at a time in sandbanks (Chaudhuri).

There is a good coloured sketch of a nearly adult specimen of *K. dhongoka* in the Hardwicke Collection of Drawings (No. 4).

36. **Kachuga kachuga.**

Emys kachuga Gray, Illus. Ind. Zool. pt. 5, pl. 9, 1831=vol. i, pl. 74 (type loc. N. India).

Emys dentata (in part) Gray, Syn. Rept. 1831, p. 20, and *errata* (correction of *dhor*), pls. 8–9, and (in part) Illus. Ind. Zool. ii, 1834, pl. 58, fig. 1 (only).

Emys lineata Gray, Syn. Rept. 1831, p. 23 (based on two unpublished drawings of Hardwicke's, Nos. 5 & 6, in Brit. Mus.; type loc. India).—*Batagur lineata*, Gray, Cat. Sh. Rept. 1855, p. 35, pl. 17; Anderson, Zool. Res. W. Yunnan, 1879, p. 745.—*Kachuga lineata*, Gray, Cat. Sh. Rept., Suppl. 1870, p. 56; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 54, and Fauna Brit. Ind. 1890, p. 40; Chaudhuri, Rec. Ind. Mus. vii, 1912, p. 212.

Batagur dhongoka (in part) Gray, Cat. Sh. Rept. 1855, p. 36, pl. 36.

Batagur ellioti Gray, Proc. Zool. Soc. 1862, p. 264 (type of unknown origin; Brit. Mus.); Günther, Rept. Brit. Ind. 1864, p. 40, pl. 3, fig. A.

Kachuga fusca (in part) Gray, Cat. Sh. Rept., Suppl. i, 1870, p. 56 (type loc. Pegu; Brit. Mus.).

Carapace depressed, unicarinate, the keel interrupted, most prominent upon the second and third vertebral shields, where it terminates in a point and knob in the young which disappears gradually with age; posterior margin crenulated in the young. Nuchal shield moderate, broadest behind; first vertebral as long as broad; second broader than long in the young, about as broad as long in the adult, longer than the third, with which it forms a straight transverse suture; fourth shield longest and forming a broad suture with the third. Plastron long and narrow, considerably narrower than the opening of the shell, angulate laterally in the young, truncate anteriorly, openly emarginate or notched posteriorly; the width of the bridge considerably exceeds the length of the hind lobe. The longest median suture is between the abdominal shields, the shortest between the gular; humero-pectoral suture curved or forming an obtuse angle; inguinal shield large, axillary smaller.

Head moderate; snout shorter than the orbit, slightly upturned, pointed and strongly projecting beyond the lower jaw; upper jaw feebly bicuspid in the adult; alveolar surfaces of jaws very broad, the upper with a strong median ridge, which is about midway between the outer and inner margins; bony choanæ on a level with the posterior part of the orbits. Skin of the hinder part of the head divided into shields by fine lines; digits fully and broadly webbed; limbs with narrow transversely enlarged scales.

Shell olivaceous or brownish above, yellowish below. Neck pale brown, with seven red or reddish-brown longitudinal stripes; sides of the head bluish; throat with a pair of oblong red or yellow spots. According to Anderson the top of the male head is brilliant red and the female has no red streaks upon the neck; this condition may be a seasonal one only. Buchanan-Hamilton's drawing, figured in Illus. Ind. Zool. and showing scarlet streaks upon the neck, is from an undoubted male.

Length of shell 390, breadth 295, depth 165 mm. Males are smaller.

Range. The Gangetic river system of Bengal, Nepal, and the United Provinces. Its occurrence in the Kistna and Godavari Rivers needs confirmation.

Chaudhuri states that it deposits its eggs in March, in sand on the banks of the Ganges.

As stated on the last page of Gray's 'Synopsis Reptilium,' parts i to vi of the 'Illustrations of Indian Zoology' (Jan. 1830 to April 1831) were on sale before the issue of his Synopsis. The name *kachuga*, therefore, has priority over *lineata*.

The *Emys dentata* of Gray's Synopsis, p. 20, and of Illus. Ind. Zool. pl. 8, includes the *Kachuga kachuga* and *Cyclemys dentata* of this work. Pls. 8 and 9 of the Synopsis are *K. kachuga*.

37. **Kachuga trivittata.**

Emys trivittata Dum. & Bib., Erp. Gen. ii, 1835, p. 331 (type loc. "Bengal"; Paris Mus. Nat. Hist.).—*Batagur trivittata*, Theobald, Cat. Rept. Brit. Ind. 1876, p. 20; Anderson, Zool. Res. W. Yunnan, 1879, p. 730, pls. 62 & 63.—*Kachuga trivittata*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 55, and Fauna Brit. Ind. 1890, p. 41, fig. 12.

Kachuga peguensis Gray, Proc. Zool. Soc. 1869, p. 200, fig. 12 (type loc. Pegu; Brit. Mus.); Theobald, Proc. Asiat. Soc. Bengal, 1874, p. 83.

Kachuga trilineata Gray, Proc. Zool. Soc. 1869, p. 200, fig. 13 (type loc. Pegu; Brit. Mus.).

Kachuga fusca (in part) Gray, Cat. Sh. Rept., Suppl. i, 1870, p. 56 (type loc. Nepal; Brit. Mus.).

Batagur iravadica Anderson, Zool. Res. W. Yunnan, 1879, p. 736, pls. 64, 65, & 75 B, figs. 16–20 (type loc. Pegu and Bhamo, Burma).

Very closely allied to *Kachuga kachuga*, but differing in the following particulars:—

Alveolar surfaces of jaws broad, that of the upper with a strong median ridge which is nearer to the inner than the outer margin; bony choanæ on a level with the middle of the orbits.

Shell of the male: above pale olive-green with a conspicuous black vertebral and two lateral stripes, which may be united at their extremities; below pale orange-yellow. Shell

of the female: dark brownish, both above and below. Head and neck olivaceous; a large black lozenge-shaped patch on the top of the head, sometimes only a streak; limbs yellowish.

Length of shell 580, breadth 390, depth 240 mm. Males are smaller, the shell not exceeding 460 mm. in length.

Range. Burma; the Irrawaddy and Salween Rivers; said to be fairly common in the Irrawaddy as far north as Bhamo.

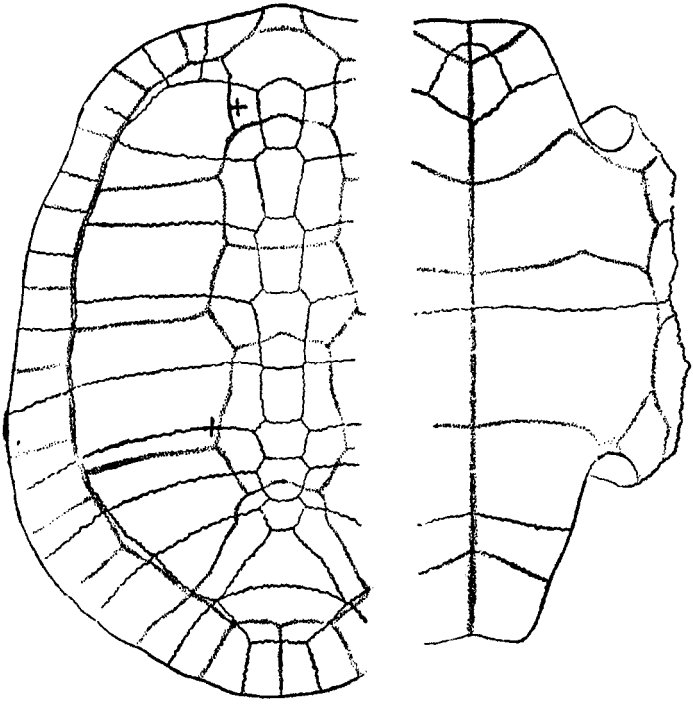

Fig. 28.—Shell of *Kachuga trivittata.*

Eggs about 25 in number, are deposited in December and January in sand-banks above tidal limits. Size 70–75× 40–42 mm.

Anderson maintained that his *Batagur iravadica* was distinct from *trivittata*, the male of the former not having black streaks on the carapace. Theobald's explanation is more likely the correct one, namely, that *iravadica* is only an immature *trivittata*, as the black markings, being a sexual character, do not appear until the creature is mature.

Genus **BATAGUR**.

Batagur (in part) Gray, Cat. Sh. Rept. i, 1855, p. 35, and Suppl. i, 1870, p. 51 (type *Emys baska*) ; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 61, and Fauna Brit. Ind. 1890, p, 38.
Tetraonyx (not of Latreille, 1809) Lesson, Illus. Zool. 1832, pl. vii (type *longicollis*).

Neural plates elongate, hexagonal, short-sided in front. Plastron extensively united to carapace by suture, with extremely developed axillary and inguinal buttresses, which extend nearly to the neural plates, the former connected with the first rib ; entoplastron anterior to the humero-pectoral suture. Skull with a bony temporal arch, the quadrato-jugal being in contact with the jugal and post-orbital ; bony choanæ on a level with the posterior part of the orbits ; alveolar surfaces of jaws very broad with two strong denticulated ridges. Digits fully webbed, with four claws only. Tail very short, not longer in the young than in the adult. A single species.

38. **Batagur baska.** (Plate I, fig. 2.)

Emys baska Gray, Illus. Ind. Zool. pt. 4, pl. 8, 1830 (vol. i, pl. 75), and Syn. Rept. 1831. p. 24 (type loc. India).—*Batagur baska*, Gray, Cat. Sh. Rept. i. 1855, p. 35, pl. 16 ; Günther, Rept. Brit. Ind. 1864, p. 37, pl. 3 ; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 61, and Fauna Brit. Ind. 1890, p. 38 ; Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 456; Maxwell, Govt. Rep. Turtle Banks, Irrawaddy, 1911.—*Batagur* (*Tetraonyx*) *baska*, Anderson, Zool. Res. W. Yunnan, 1879, p. 771, pls. 66–67.
Emys batagur Gray, Syn. Rept. 1831, p. 23, and Illus. Ind. Zool. ii, 1834, pl. 59 (type loc. India).
? *Trionyx cuvieri* Gray, Syn. Rept. 1831, p. 50.
Tetraonyx longicollis Lesson, Illus. Zool. 1832, pl. vii (type loc. Pegu ; Mus. Nat. Hist. Paris) ; Anderson, Zool. Res. W. Yunnan, 1879, p. 771.
Emys tetraonyx Schlegel, Fauna Japon. 1834, p. 43 (subst. name for *T. longicollis*).
Tetraonyx lessonii Dum. & Bib., Erp. Gen. ii, 1835, p. 338, pl. xvi (subst. name for *E. batagur*).
Tetraonyx affinis (in part) Cantor, Cat. Malay Rept. 1847, p. 6.

Carapace smooth, moderately depressed, with an interrupted vertebral keel in the young which disappears in the adult. Nuchal shield broader than long ; second and third vertebrals subequal, fourth smaller, these shields much broader than long in the young, about as broad as long and as broad as or a little narrower than the costals in the adult. Plastron considerably smaller than the shell-opening, strongly angulate laterally in the young, rounded in the adult, truncate anteriorly, notched posteriorly ; the width of the bridge considerably exceeds the length of the hind lobe ; the longest median suture is between the abdominal shields, the shortest between the gular ; inguinal shield large, axillary smaller.

Head rather small; snout upturned, pointed, and strongly projecting; upper jaw with a mesial notch; skin of hinder part of head divided into small shields: limbs with very narrow transversely enlarged scales.

Shell olive-brownish or greenish above, yellow below; soft parts dull olive above, paler below. According to Anderson (1879) the male at certain seasons of the year has "the area around the nostrils pale bluish, but all the rest of the head and under surface of the neck are deep black, passing into a rich crimson on the base of the neck, the whole of the fore-limb being brilliant rosy carmine. The hind parts are dull reddish purple. Eye greenish yellow."

Length of shell 590, breadth 430, depth 210 mm. There appears to be no great disproportion in size between the sexes.

Range. Bengal, Burma to Cochin-China and the Malay Peninsula; Sumatra.

Batagur baska is herbivorous and entirely aquatic in its habits, and of exceedingly shy disposition. It inhabits estuaries, deep slow-flowing rivers, and canals. Maxwell (1911) has some interesting notes on the breeding-habits of *Batagur baska* in the estuary of the Irrawaddy. They lay from the beginning of January or a little earlier until the end of February or beginning of March. Every day, quite irrespective of the state of the tide, the tortoises come out of the sea and sun themselves on the sand from about 2 P.M. till dark. They assemble in herds of from one to five hundred, lying quite close to one another. Every night some of them lay their eggs, between ten and thirty in number, in the sand of the beach, digging a hole for them from one and a half to two feet deep, above the influence of the tides. On no consideration will the tortoises allow themselves to be approached: directly they wind a human being they disappear into the sea. After the tortoises have been laying for about six weeks a raid is made on the banks, and men poking about with sticks easily find the nests and take the eggs. They measure from 70–75 mm. in length and 40–45 in breadth and weigh about three ounces. The period of incubation is said to be 70 days.

Altogether between 50 and 60 eggs are laid by each female. They are deposited in three batches, the time for the whole occupying about six weeks. During this period the tortoises eat nothing, so that on their return to the tidal estuaries they are ravenously hungry. There they are trapped in large numbers by the Burmans for the sake of their flesh. The chief method employed is a form of basket-trap baited with the leaves of the *thamé* tree. Whether the abstinence from food is due to the excitement of mating or because their proper food is not available is not known.

Family TESTUDINIDÆ.

THE LAND TORTOISES.

Testudinidæ Gray, Ann. Phil. (2) x, 1825, p. 210; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 48, and Fauna Brit. Ind. 1890, p. 18 (in part).—*Testudininæ*, Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 508.

Neck completely retractile within the shell. Nuchal plate without well developed costiform process; plastral bones nine. Ear chamber completely closed behind by the quadrate; temporal region not roofed over; a bony temporal arch; digits with not more than two phalanges; metacarpals not or but slightly longer than broad. Shell covered with epidermal shields, those of the plastron in contact with the marginals. Head shielded above. Eggs more or less spherical in shape. Scent glands appear to be absent in all the *Testudinidæ*.

The typical Land Tortoises are widely distributed over the warm parts of the earth, except Australia and Papuasia. Four genera are recognized; the majority of the species belong to the genus *Testudo*.

Gigantic land tortoises (*Colossochelys*), allied to *Testudo*, existed in India during the Pliocene Period; fragments that have been referred to several species have been found in the Siwalik Hills (Lydekker, Paleont. Ind. (x) iii, 1886, p. 157).

Genus TESTUDO.

Testudo (in part) Linnæus, Syst. Nat. ed. 10, 1758, p. 197 (type *græca* *); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 149, and Fauna Brit. Ind. 1890, p. 19; Annandale, Rec. Ind. Mus. ix, 1913, p. 75.

Geochelone Fitzinger, Ann. Wien Mus. i, 1835, p. 111 (type *Testudo stellata* Schweigger).

Manouria Gray, Proc. Zool. Soc. 1852, p. 133 (type *fusca*).

Teleopus Leconte, Proc. Acad. Nat. Sc. Philad. 1854, p. 187 (type *luxatus*).

Scapia Gray, Proc. Zool. Soc. 1869, p. 167 (type *falconeri*).

Testudinella (not of Bory, 1826) Gray, Cat. Sh. Rept. 1870, p. 12 (type *Testudo horsfieldii*).

Peltastes (not of Rossi, 1807) Gray, Proc. Zool. Soc. 1869, p. 171, and Cat. Sh. Rept., Suppl. i, 1870, p. 8 (type *Testudo elongata*).

Indotestudo Lindholm, Zool. Anz. lxxxi (11/12), 1929, p. 285 (type *Testudo elongata*).

For a full synonymy see Boulenger, Cat. Chel. 1889, p. 149, Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 515, and Lindholm, Zool. Anz. lxxxi (11/12), 1929, p. 284.

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* = *T. ibera* Pallas auct.

Neural plates hexagonal, short-sided behind, or alternately tetragonal and octagonal; costal plates alternately narrower and wider. Plastron extensively united to carapace by suture with short axillary and inguinal buttresses which do not reach or just reach the costal plates. Alveolar surface of upper jaw with a more or less developed median ridge. Choanæ on a level with the anterior half of the orbits. Limbs more or less cylindrical, the hinder ones club-shaped, covered with enlarged, often bony, scales. Digits very short, not webbed. Tail short, not longer in the young than in the adult.

Cosmopolitan, except Australia and Papuasia. The genus contains some 40 or 50 species; it includes the Giant Tortoises of the Galapagos Islands and the islands of the western Indian Ocean, and the small *T. leithi*, the shell of which only measures 120 mm. in length. All the species are terrestrial and herbivorous in their habits.

Lindholm has recently (1929) divided this large genus into a number of subgenera.

Testudo leithi Günther, the type of which was said to have come from Sind, is not included here. It is a native of Egypt and Syria.

Key to the Species.

I. Fore-limb with five claws.
  A. Supracaudal shield single.
    a. Carapace black, with yellow areolæ and yellow radiating streaks; entoplastron anterior to humero-pectoral suture.
Vertebral and costal shields forming distinct humps in the adult; plastron with dark radiating lines; top of head covered with irregular shields ..... *elegans*, [p. 138.
Vertebral and costal shields not humped; plastron without dark radiating lines; a frontal and a pair of prefrontals more or less distinct..... *platynota*, [p.140.
    b. Carapace yellow, with black blotches; entoplastron intersected by humero-pectoral suture.
A nuchal shield (rarely absent); suture between the pectoral shields equal to or longer than that between the humeral ..... *elongata*, [p. 141.
No nuchal shield; suture between the pectoral shields shorter than that between the humeral ..... *travancorica*, [p. 143.
  B. Two supracaudal shields; entoplastron anterior to humero-pectoral suture.
Vertebral shields more or less convex in the adult; pectoral shields usually widely separated from one another; carapace dark horn or blackish..... *emys*, p. 144.
Vertebral shields flat or concave; pectoral shields in contact with one another; carapace light brown, the shields usually with black margins ..... *impressa*, [p. 145.

II. Fore-limb with four claws; entoplastron intersected by humero-pectoral suture ..... *horsfieldi*, [p. 146.

39. Testudo elegans.

Testudo elegans Schoepff, Hist. Test. 1792, p. 111, pl. xxv (type loc. India); Günther, Rept. Brit. Ind. 1864, p. 4; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 161, and Fauna Brit. Ind. 1890, p. 21, fig. 6; Haly, J. Asiat. Soc. Ceylon, xiii, 1894, p. 128, fig.; Annandale, Mem. Asiat. Soc. Bengal, i, 1906, p. 185; Deraniyagala, Ceylon J. Sc., Sect. B, xvi, 1930, p. 58.

Testudo stellata Schweigger, Prod. Chel. 1814, p. 56 (type loc. India).

Testudo actinodes Bell, Zool. Journ. iii, 1828, p. 419, pl. xxiii (type loc. "Africa," corrected to India and Madagascar in Monogr. Test. 1835, pls. 10 & 11; Brit. Mus.); Sowerby & Lear, Tort., Terr. & Turtles, 1872, pls. xi & xii.

Testudo geometrica, Hutton, J. Asiat. Soc. Bengal, vi, 1837, p. 689, pl. 38.

Testudo megalopus Blyth, J. Asiat. Soc. Bengal, xxii, 1853, p. 640 (type loc. unknown).

Carapace elongate, very convex, the vertebral and costal shields forming distinct, sometimes very marked, humps in the adult, the apex of each hump corresponding with the areola; lateral margins of carapace nearly vertical; anterior and posterior margins reverted, the latter strongly serrated. No nuchal shield: first vertebral longer than broad; second to fourth broader than long, as broad as or narrower than the corresponding costals; supracaudal shield undivided, more or less incurved. Plastron large, truncate or openly notched anteriorly, deeply notched posteriorly: the suture between the abdominal shields is considerably longer than that between any of the other plastral shields; the shortest is that between the pectoral or the anal, in the adult: axillary and inguinal shields rather small.

Head moderate, forehead swollen, convex; top of head covered with rather small irregular shields; upper jaw feebly tricuspid. Front of arm and heel with large, imbricate, pointed, bony scales: a patch of large conical ones on the back of the thigh; tail terminating in a spur-like scale.

Shell black above, each vertebral and costal shield with a yellow areola from which radiate yellow streaks, usually eight or more in number; plastron also with black rays upon a yellow ground. In old individuals the markings are often scarcely distinguishable. Head and limbs yellow, more or less spotted with dark brown or black.

In the very young the shell is almost entirely yellow or orange, with black marks along the sutures.

The amount of humping and the distinctness of the colour-pattern are variable, and in some individuals, perhaps owing to disease, may be almost indistinguishable. A series of seven specimens recently collected on Ramaswaram Island, Southern India, by the Bombay Natural History Society shows these variations well. Three out of this series are now in the British Museum.

Length of shell 250, breadth 160, depth 120 mm. Males are smaller.

Range. The Starred Tortoise is distributed throughout Central and Southern India, extending west as far as Sind and south to Ceylon. It is the common land tortoise over the greater part of the Madras Presidency. Deraniyagala states that in Ceylon it is " a forest dweller, found in dry areas of the low country. Although in captivity it drinks large quantities of fresh water daily: the animal abounds on islands and in localities where the only water-supply available is brackish, except during the monsoons."

Hutton has given a most interesting account of its habits both in the wild state and in captivity, and as observations upon tortoises are not often recorded, I have quoted from him extensively. He writes:—" These animals are by no means of rare occurrence in the hilly tracts of Mewar (Udaipur) and the adjoining districts, where they are found in the high grassy jungles skirting the base of the hills. They are not easily procured, as their colour and appearance blend so closely with their surroundings that it is difficult to distinguish them; added to which they remain in concealment beneath shrubs or tufts of grass during the heat of the day. It is in the rainy season that they are in the greatest activity, and wander about all day feeding and coupling. At the approach of the cold weather they select a sheltered spot and conceal themselves in some thick tuft of grass or bushes, the better to protect them from the cold, remaining thus in a sort of lethargic inactivity (for they are not torpid) until the hot season. In captivity (at this season) they remained all day in concealment, coming out a little before sunset to feed on grass, lucerne, and cabbage leaves. As night approached they did not again retire, but as if enjoying the cool air, remained stationary until morning, when they withdrew to their retreats before the sun rose. They did not wander about at night, but remained as if asleep. At this season, too, they were fond of plunging into water, where they would often remain for half an hour at a time. They drank a great deal of water, which they took by thrusting in the head and swallowing it by draughts.

" During the whole period of the rains, nearly four months, copulation took place frequently. On the 11th November one of the females commenced sinking a pit to receive her eggs. Selecting a retired spot at the root of a tuft of grass, she began to moisten the earth with water which she produced from the vent, and then with the strong horny toes of her hind-feet proceeded to scrape away the mud she had made. She used her hind-feet alternately, and as she continued the water was supplied drop by drop so as to render the earth muddy and

easy to be scraped out of the pit she was making. In about two hours she had made a hole 6 inches deep and 4 in diameter, and into this she deposited her eggs, four in number, filling up the hole again with her wet mud, and then treading it well in and stamping upon it with her hind-feet until it was filled to the surface, when she beat it with the whole weight of her body, raising herself behind as high as she could stretch her legs and suddenly withdrawing them, allowing herself to drop heavily upon the earth, by which means it was speedily beaten flat; so smooth and natural did it appear that had I not seen her I should never have noticed the spot where she had deposited her eggs. The whole operation occupied about four hours."

The eggs measure 45–46 mm. in length by 35–37 in breadth.

40. Testudo platynota.

Testudo platynota Blyth, J. Asiat. Soc. Bengal, xxxii, 1863, p. 83 (type loc. Irrawaddy Valley; Brit. Mus. and Ind. Mus.); Theobald, Cat. Rept. Mus. Asiat. Soc. 1868, p. 9; Anderson, Zool. Res. W. Yunnan, 1879, p. 712; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 162, and Fauna Brit. Ind. 1890, p. 22.—*Peltastes platynotus*, Gray, Proc. Zool. Soc. 1870, p. 655, pl. 33.

Carapace very convex, not so elongate as in *T. elegans*, the vertebral and costal shields not humped; lateral margins nearly vertical, posterior margin feebly serrated. No nuchal shield; first vertebral longer than broad, second to fourth vertebrals broader than long, as broad as or broader than their corresponding costals; supracaudal shield undivided, more or less incurved. Plastron large, notched anteriorly and posteriorly; the suture between the abdominal shields is considerably longer than that between any of the other plastral shields; the pectoral shields are very narrow and the suture between them very short; axillary shield smaller than the inguinal.

Head moderate; a pair of prefrontals and a large frontal shield usually distinct, the rest of the head being covered with smaller shields; upper jaw feebly tricuspid. Front of arm with large, pointed, bony scales, heels with flat ones; a patch of enlarged, flattish or pointed scales at the back of the thigh. Tail terminating in a spur-like tubercle.

Shell black above, each vertebral and costal shield with a yellow areola and radiating streaks usually not more than six in number. Yellow below, each plastral shield with a regular dark brown patch. Head and limbs yellowish, the large scales upon the limbs being bright yellow.

Length of shell 260, breadth 155, depth 120 mm. Blyth gives the length of one of his types, a carapace only, as 280 mm.

Range. Burma as far south as Moulmein. Anderson states that it is generally distributed over Upper Burma.

Testudo platynota was originally described from three carapaces which Blyth purchased in the bazaar at Rangoon, where they were used for baling oil out of earthen vessels. He states that the carapaces were used abundantly for this purpose, but that the entire animals were difficult to obtain as the Burmans were so fond of eating them.

The eggs are large and few in number; they measure 40×55 mm. and are deposited at the end of February.

41. **Testudo elongata.**

Testudo elongata Blyth, J. Asiat. Soc. Bengal, xxii, 1853, p. 639 (type loc. Tenasserim; Ind. Mus.); Gray, Proc. Zool. Soc. 1856, p. 181, pl. 9; Anderson, Zool. Res. W. Yunnan, 1879, p. 706; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 173, and Fauna Brit. Ind. 1890, p. 20; Siebenrock, SB. Akad. Wiss. Wien, cxii, 1903, p. 346; Annandale, Rec. Ind. Mus. xi, 1915, p. 347.

Testudo parallelus Annandale, Rec. Ind. Mus. ix, 1913, p. 76 (type loc. Chaibasa District, Chota Nagpur; Ind. Mus.).

Carapace convex, elongate, flattened on the vertebral region in the adult, anterior and posterior margins slightly reverted, strongly serrated in the young, feebly in old specimens. Nuchal shield long and narrow, rarely absent; first vertebral shield usually about as broad as long; second to fourth vertebrals broader than long and about as broad as the corresponding costals; supracaudal shield undivided, more or less incurved. Plastron large, truncate anteriorly, deeply notched posteriorly; the longest median suture is between the abdominal shields, the shortest between the anal shields, which may be entirely separated by the anal notch; suture between the pectoral shields as long as or longer than that between the humeral in the adult; axillary shield usually smaller than the inguinal. Head moderate; a pair of prefrontal shields and a large frontal often subdivided, always present; the rest of the head covered with smaller shields; upper jaw tricuspid; horny margins of jaws feebly denticulated. Fore-limb with large, imbricate, pointed scales, particularly along the outer side; heel with large flat scales; a patch of enlarged flattened scales on the hinder part of the thigh; tail terminating in a horny tubercle, longer and curved in the male than in the female.

Shell greenish-yellow above and below, each shield with an irregular black spot or blotch, which may occupy its greater part or be broken up; rarely the black markings are absent. Head pale greenish-yellow; limbs darker, with small irregular dark spots.

Length of shell 275, breadth 165, depth 105 mm.

Variation. The nuchal shield is sometimes absent. Anderson states that in 86 individuals examined by him it was absent in four of them. In 60 specimens examined by me it was

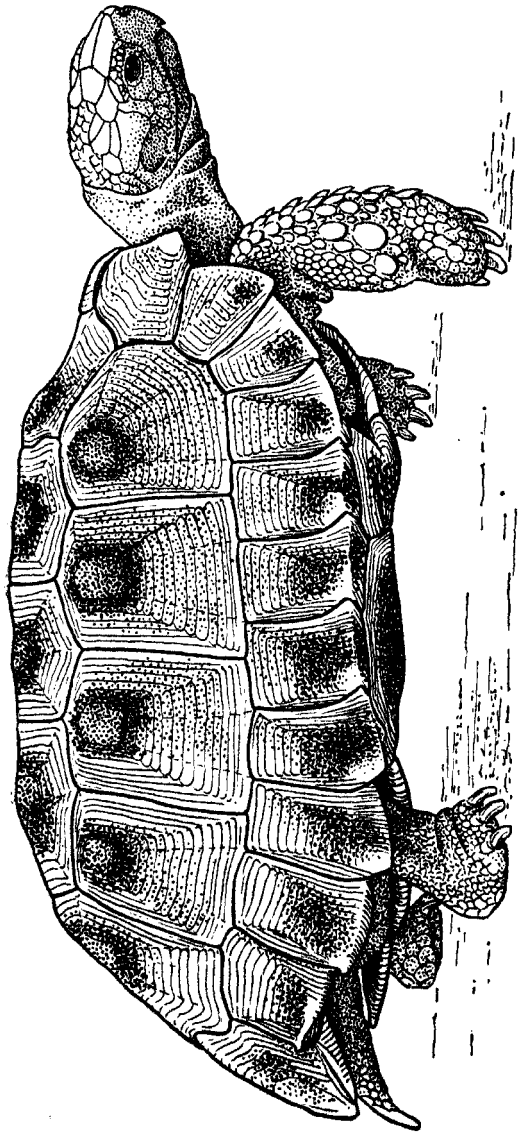

Fig. 29.—*Testudo elongata.*

absent in one, this example being abnormal also in other respects.

Range. From north-eastern India to Tonkin (Than-Moi) and the Malay Peninsula as far south as Penang. It is rare in the northern part of its range, comparatively common in the southern. Hodgson obtained a specimen in the Saul * forests of Nepal, and has left a fine coloured sketch of it in his collection of drawings. *T. parallelus*, which I have placed in the synonymy of *elongata*, is from Chota Nagpur. Anderson (1879) refers to specimens of *elongata* from the same district, but unfortunately they cannot now be found (Annandale, 1913). These are the only records of *elongata* in peninsular India. It does not occur in the valley of the Ganges. Annandale in describing his *T. parallelus* notes its resemblance to *elongata*, and comments upon the fact that a form showing such close affinities to a purely Indo-Chinese species should occur also in the Indian Peninsula. That it ever crossed the Gangetic Plain as we know it to-day is, of course, highly improbable. A more likely explanation is to be sought for in the antiquity of *Testudo*, *T. elongata*, *T. parallelus*, and *T. travancorica*, being the descendants of an ancestor that once ranged over India and Indo-China when the geographical conditions of the country were very different from what they are to-day. *T. travancorica* has become just sufficiently distinct to be separated off from *elongata*, *T. parallelus*, in my opinion, has not *Geoemyda tricarinata* has a distribution similar to that of *T. elongata*, occurring in Chota Nagpur and in the hills of Assam, although it does not extend further into the Indo-Chinese Peninsula.

Testudo elongata is the commonest land tortoise of southern Burma, Siam, and Cambodia. It inhabits the hilly districts chiefly at low altitudes. Its capacity for withstanding heat is remarkable. Mr. K. G. Gairdner, of the Bombay Burma Trading Corporation, has told me that he has often found it crawling about on the open hill-sides in Siam during the day, when the heat of the ground was so great that the hand could hardly bear to touch it. It is known to the Burmans as " laik nakhonga " or the Red-nosed Tortoise, a name given to it because the skin round the nostrils and eyes is of a pinkish colour in life in the adult. I have not observed this coloration in individuals from Siam. It may be a seasonal variation.

42. Testudo travancorica.

Testudo travancorica Boulenger, J. Bombay Nat. Hist. Soc. xvii, 1907, p. 560, 2 pls. (type loc. Travancore Hills; Brit. Mus.); Ferguson, ibid. xviii, 1907, p. 186; Annandale, Rec. Ind. Mus. xi, 1915, p. 191.

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* The Sal- or Teak tree (*Shorea robusta*).

Very closely allied to *T. elongata*, from which it differs in the following characters :—Nuchal shield always absent ; suture between the pectoral shields shorter than that between the humeral ; frontal shield usually larger and not subdivided.

Coloration and size as in *elongata*.

Range. The hills of Travancore, where it is not uncommon up to an altitude of 1000 metres. Specimens have been obtained at Travancore and Cochin on the western slopes of the Western Ghats, and Coorg on the eastern slopes.

43. **Testudo emys.**

Testudo emys Schleg. & Müll., in Temminck, Verh. Nat. Ned. Ind. Rept. 1844, p. 34, pl. iv. (type loc. Sumatra ; Leiden Mus.) ; Anderson, Proc. Zool. Soc. 1872, p. 132, figs. ; (in part) Boulenger, Cat. Chel. Brit. Mus. 1889, p. 158, and Fauna Brit. Ind. 1890, p. 22 ; Siebenrock, Zool. Anz. xxx, 1906, p. 583, and Zool. Jahrb. Jena, Suppl. 10, 1909, p. 519 ; Mell, Arch. Naturgesch. lxxxviii (10), 1922, p. 114.—*Manouria emys*, Tirant, Notes Rept. Batr. Cochin-China, 1885, p. 12.

Testudo emydoides Dumeril, Cat. Meth. Rept. 1851, p. 4.

Manouria fusca Gray, Proc. Zool. Soc. 1852, p. 134 (type loc. Singapore ; Brit. Mus.), and Cat. Sh. Rept. 1855, p. 16, pl. 3, and Proc. Zool. Soc. 1860, p. 395, pl. xxxi, and Cat. Sh. Rept., Append. 1872, p. 7.

Testudo phayrei Blyth, J. Asiat. Soc. Bengal, xxii, 1853, p. 639 (type loc. Arakan and Tenasserim ; Ind. Mus.).

Teleopus luxatus Leconte, Proc. Acad. Nat. Sc. Philad. 1854, p. 187 (type loc. Java).

Testudo (*Scapia*) *falconeri* Gray, Proc. Zool. Soc. 1869, p. 169, figs. (type loc. ? India).

Scapia gigantea Gray, Cat. Sh. Rept., Append. 1872, p. 8.

Carapace convex, not flattened on the vertebral region in the adult ; anterior and posterior margins reverted and more or less strongly serrated ; costal shields in the adult sometimes concave. Nuchal shield moderate ; vertebral shields broader than long, at least as broad as the corresponding costals ; two supracaudal shields. Plastron large, sometimes longer than the carapace owing to the extended gular shields ; openly notched anteriorly, deeply notched posteriorly ; the suture between the abdominal shields is much longer than that between any of the other plastral shields ; the pectoral shields are usually widely separated from one another ; inguinal shields large, often divided into two, axillary shield smaller.

Head moderate ; top of the head covered with more or less symmetrical shields, a large frontal and two pairs of shields anterior to it being constantly present ; upper jaw feebly hooked. Front of fore-limb with large, pointed, bony, imbricate scales, forming four or five longitudinal series ; hind-limb with large, pointed scales on the sole and heel ; a patch of pointed scales on the back of each thigh. Tail terminating in a grooved spur-like tubercle.

Shell dark brown or blackish, of the young much paler ; head and limbs blackish.

Length of shell 470, breadth 340, depth 195 mm.

Range. Assam (Cachar, Naga Hills) ; Burma ; Siam : the Malay Peninsula and Archipelago. I cannot find any definite records of its occurrence east of Siam. Tirant (1885) states that he bought a plastron in the market at Saigon ; Mell (1922) that he has obtained them in the market at Canton ; Siebenrock (1906) records it from the mouth of the Yang-Tse Kiang. There is no other evidence to show that the species exists in these localities, and it is possible that the ones referred to were imported specimens.

Testudo emys is the largest of the Asiatic species of *Testudo*. It inhabits hilly districts and is fond of water. Its conspicuous size and slow movements render it an easy prey to the country people, and whenever met with it is killed for the sake of its flesh.

Its eggs measure 43 × 50 mm.

44. **Testudo impressa.**

Geoemyda impressa Günther, Proc. Zool. Soc. 1882, p. 343, figs. (type loc. Siam ; Brit. Mus.).—*Testudo impressa*, M. A. Smith, J. Nat. Hist. Soc. Siam. iv. 1922, p. 204.

Testudo emys, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 158 (in part), and Fauna Brit. Ind. 1890, p. 22 (in part), and Ann. Mus. Civ. Genova, (2) xiii, 1893, p. 312.

Geoemyda latinuchalis Vaillant, Bull. Soc. Philom. Paris, (8) vi, 1894, p. 68 (type loc. Tonkin ; Paris Mus. Nat. Hist.).—*Testudo latinuchalis*, Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 520.

Testudo pseudemys Boulenger, Fascic. Malay., Zool. i. 1903, p. 144, pl. ix, text-fig. (type loc. Perak ; Brit. Mus.).

Carapace much flattened on the vertebral region, the vertebral shields sometimes, and the costals always, concave in the adult ; anterior and posterior margins reverted and strongly serrated. Nuchal shield rather large, triangular ; vertebrals broader than long, as broad as or broader than the corresponding costals ; two supracaudal shields. Plastron large, not longer than the carapace, openly emarginate anteriorly, deeply notched posteriorly ; the suture between the abdominal shields is much longer than that between any of the other plastral shields ; the shortest suture is between the pectoral shields ; inguinal shield large, often double, axillary shield smaller. Head and limbs as in *T. emys*.

Shell light brown above, the margins of the discal shields usually paler, and with or without dark radiating marks ; yellowish-brown below, with more or less distinct dark brown marks or radiating streaks. Head yellow, limbs brown or blackish. Young specimens are light yellowish-brown above, finely speckled with black.

Length of shell 260, breadth 195, depth 95 mm.

Range. Burma (Karenni Hills); Siam; Annam (Langbian Plateau); Tonkin; the Malay Peninsula. Found only in the hills at considerable altitudes.

45. **Testudo horsfieldi.**

Testudo horsfieldi Gray, Cat. Tort., etc., Brit. Mus. 1844, p. 7, and Cat. Sh. Rept. 1855, p. 7, pl. i (type loc. Afghanistan; Brit. Mus.); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 178; Annandale, J. Asiat. Soc. Bengal, ii, 1906, p. 204; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 543.

Homopus burnesii Blyth, J. Asiat. Soc. Bengal, xxii, 1853, p. 642 (type loc. Afghanistan; Ind. Mus.).

Testudo baluchiorum Annandale, J. Asiat. Soc. Bengal, ii, 1906, pp. 75, 205, pl. ii, fig. 1 (type loc. Baluchistan; Ind. Mus.).

Carapace depressed, not much longer than broad, usually flattened on the vertebral region. Anterior and posterior margins somewhat expanded, crenulated in the young. Nuchal long and narrow; vertebrals considerably broader than long, about as broad as the corresponding costals; supracaudal shield undivided. Plastron large, truncate or openly emarginate anteriorly, notched posteriorly, flat in both sexes. Much the longest suture is that between the abdominal shields; the shortest is between the femoral or the pectoral shields; axillary and inguinal shields small.

Head rather small; top of head with symmetrical shields, a frontal and a large pair of prefrontals being constant.

Upper jaw tricuspid. Anterior aspect of fore-limb, heel and plantar surface of foot, with enlarged, more or less pointed, imbricate, bony scales; a group of pointed scales on the back of the thigh; tail terminating in a horny tubercle, curved and longer in the male than in the female. Limbs with four claws only.

Shell yellow or yellowish-brown, each shield with a black blotch variable in size; on the plastron these may cover almost the entire shield; rarely they are absent altogether. Head and limbs yellowish.

Length of shell 195, breadth 155, depth 95 mm.

Range. From the Caspian and Aral Seas to the north-eastern corner of British India. Annandale records having received 23 living examples from Kalat in Baluchistan, and there are the head and limbs of a specimen from Wano, Waziristan, in the Museum of the Bombay Natural History Society. Annandale remarks that "it is an active species, walking with considerable rapidity, very high on its legs. When eating or drinking it occasionally emits a low croak like that of a frog. Captive specimens concealed themselves during the heat of the day and at night, feeding at dusk and in the early morning. They were fond of most flowers and fruits and of the thick fleshy leaves of various plants; but they generally refused to eat grass. They drank water

greedily. A female killed towards the end of May contained five fully-formed eggs, 50×35 mm. in size.

In the type of *Testudo baluchiorum* the carapace is arched instead of being depressed, but in other characters it resembles *horsfieldi*. It is an unusually large specimen, the shell measuring 220×160×103 mm.

Superfamily TRIONYCHOIDEA.

Amydæ (in part) Oppel. Ordn. Rept. 1811, p. 6.
Trionychoidea Fitzinger, Neue Class. Rept. 1826, p. 7; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 237, and Fauna Brit. Ind. 1890, p. 9; (in part) Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 586.
Chilotæ Wiegmann, Handb. Zool. 1832, p. 167; Stejneger, Herpet. Japan, 1907, p. 513, with further synonymy.

Neck bending in a sigmoid curve in a vertical plane; last cervical vertebra articulating with the first dorsal by a double facet on the centrum and by the zygapophyses, or by the latter only. Pterygoids separated from each other, the basisphenoid joining the palatines. Pelvis not anchylosed to the carapace and plastron. Carapace and plastron covered with soft skin, without epidermal shields. Phalanges elongate. Fore-limb semipaddle-shaped with two or three claws only. Two families.

Carettochelys insculpta, the sole representative of its family, although placed here among the Trionychoidea, has affinities in a nearly equal degree with the Pleurodira. It is a native of New Guinea.

Family TRIONYCHIDÆ.

Freshwater Turtles. Mud Turtles.

Trionicidæ (in part) Gray, Ann. Phil. (n. s.) x, 1825, p. 212.
Trionychidæ Bell, Zool. Journ. iii, 1828, p. 515; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 241, and Fauna Brit. Ind. 1890, p. 9; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 589; Annandale, Rec. Ind. Mus. vii, 1912, p. 151.
Chitradæ Gray, Cat. Sh. Rept., Suppl. 1870, p. 89.
Emydinadæ Gray, id. p. 117.

Articulation between the last cervical and first dorsal vertebræ by the zygapophyses only; epiplastra separated from hyoplastra by a Λ-shaped entoplastron; marginal bones absent or forming an incomplete series, not connected with the ribs. Fourth digit with four or more phalanges; only the three inner digits clawed. Head and neck completely retractile; ear hidden. Jaws concealed under fleshy lips; snout ending in a proboscis. Plastron united to carapace by ligamentous tissue.

Geologically the Trionychidæ do not seem to be very old. They appear first in the Upper Cretaceous strata of North America.

The recent species fall into two natural groups, both of which inhabit the Indian region. Their distinguishing characters are as follows :—

I. Plastron with a cutaneous femoral valve under which the hind-limb may be concealed ; outer extremity of nuchal bone underlying the second rib ; hyoplastron fused with hypoplastron ; posterior border of pterygoid with an ascending process which unites with the opisthotic behind the labyrinth.

Genera : *Lissemys*, *Cyclanorbis*, *Cycloderma*, the two last inhabiting Africa.

II. Plastron without femoral valves ; outer extremity of nuchal bone free, overlying the second rib ; hyoplastron distinct from hypoplastron ; posterior border of pterygoid without ascending median process, the walls of the labyrinth being completely exposed behind.

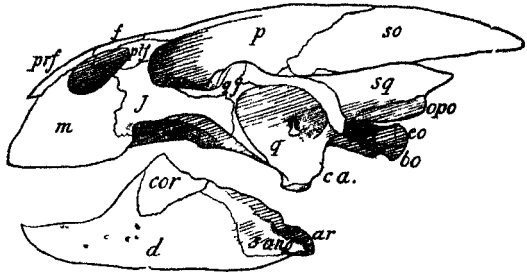
Genera : *Trionyx*, *Dogania*, *Chitra*, *Pelochelys*.

Trionyx has a wide distribution across Asia, Africa, and North America ; the remaining three genera range through India to China and the Malayan region.

The carapace of the Trionychids is incomplete peripherally, so that the ribs extend beyond the costal plates, only slightly in *Lissemys*, considerably more so in *Trionyx* and its allies. The plastron forms an incomplete shield. Its constituent nine elements are much reduced in size and are only loosely connected with one another, their pointed processes merely interdigitating instead of meeting by regular suture. A median vacuity always persists. The entoplastron and epiplastra differ entirely from their homologues in other Chelonians. The former is a Λ-shaped piece of bone, its extremities touching the anterior and inner margins of the hyoplastra. In the *Trionyx* group the epiplastra are also angular in shape, the posterior limbs being in contact with the entoplastron, so that the three bones together from a λ- or X-shaped figure ; in *Lissemys* there is only a short, straight, anterior limb to each epiplastron.

All the plates of the carapace are sculptured, pitted, vermiculated, or granulate. In the living creature this is not evident owing to the covering of skin, although it shows up more or less in the dried shell. Some or all of the plastral bones develop with age a similar sculpturing, the so-called plastral callosities. They are visible externally during life, and their presence or absence in some species of *Trionyx* has been regarded as of specific value. In the young they cannot be seen, and the age at which they develop certainly

A.



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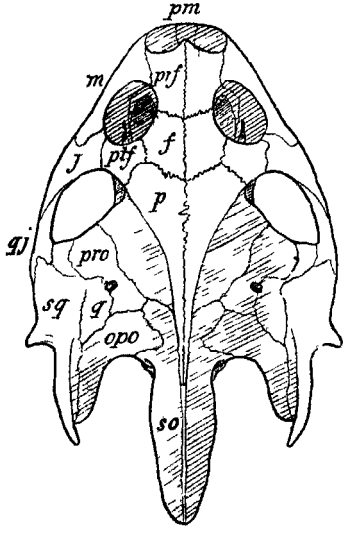

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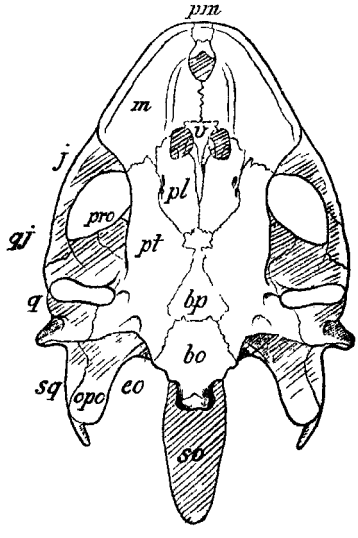

Fig 30.—Skull of *Trionyx gangeticus* (After Boulenger.)
A Side view. B. Upper view C Lower view.

ar	Articular.	*pl.*	Palatine.
bo.	Basioccipital.	*pm.*	Premaxillary
bp.	Basisphenoid.	*prf.*	Prefrontal
c a	Columella auris	*pro.*	Prootic.
cor.	Coronoid.	*pt.*	Pterygoid.
d.	Dentary.	*ptf.*	Postorbital.
eo.	Exoccipital.	*q.*	Quadrate.
f.	Frontal.	*qj.*	Quadrato-jugal
j.	Jugal.	*s.ang*	Supra-angular.
m.	Maxillary.	*so.*	Supraoccipital.
opo.	Opisthotic.	*sq*	Squamosal.
p.	Parietal.	*v*	Vomer.

varies in different individuals of the same species. In the *Trionyx* group four callosities are constantly present, namely a lateral pair upon the hyo-hypoplastral, and a posterior pair upon the xiphiplastral, bones. A fifth sometimes develops in old individuals upon the entoplastron. In *Lissemys* there are seven, the additional callosities being upon the entoplastron and the epiplastra (fig. 35). In this genus in particular the ossifications extend considerably beyond the limits of, and differ greatly in shape from, the actual plastral bones.

As already stated, the *Trionychidæ* have no horny epidermal

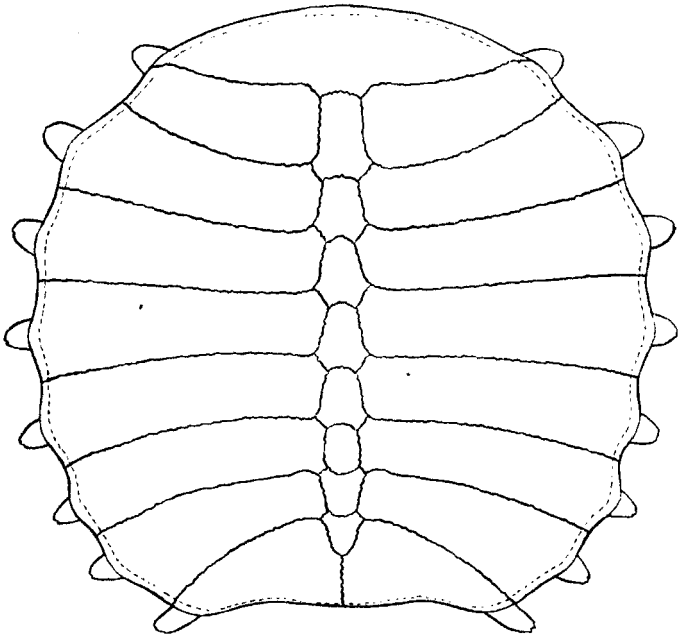

Fig. 31.—Bony carapace of *Trionyx cartilagineus*.

shields, the carapace and plastron being covered with smooth skin. The margin of the carapace is formed by a flange of dense fibrous tissue, longest posteriorly. In *Lissemys* it is comparatively short, but in *Trionyx* and its allies it is much larger and constitutes roughly one-third of the total length of the dorsal disc.

Marginal bones are present in *Lissemys*, the postero-lateral border of the dorsal disc containing a series of sculptured bones which are separated from, but appear to form a continuation of, the costal plates. They are possibly not the vestiges of the marginals of other Chelonians, but may have

had an independent origin, as in the case of the small bone which is found in front of the nuchal, the prenuchal plate.

In the *Trionychidæ* the neck is always elongate, the cervical region equalling or exceeding the length of the dorsal vertebral column. It is specially adapted for rapid and complete retraction, and to this end the articulation of the last cervical with the first dorsal vertebra is remarkable, being by the zygapophyses only instead of by the centra. The pair on the dorsal vertebra fit into concavities on the cervical, and the articulatory surfaces are so extensive that a movement through

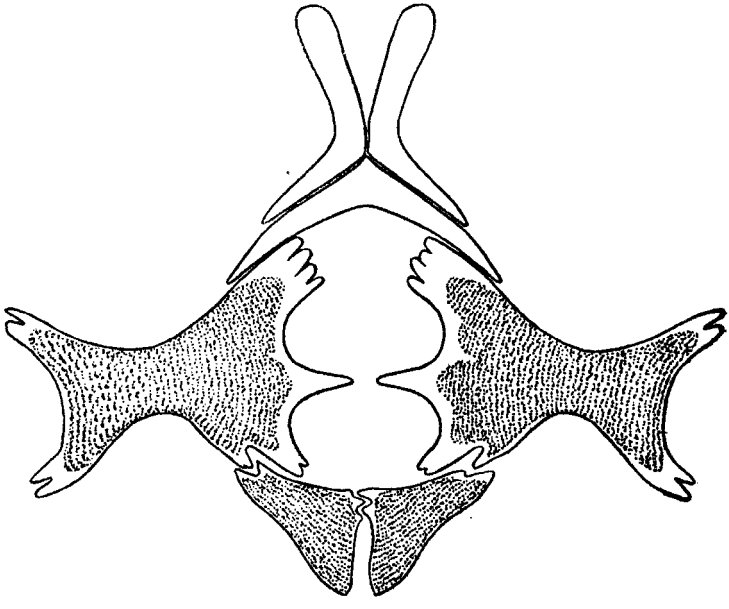

Fig. 32.—Bony plastron of *Trionyx cartilagineus*.
The hyo-hypoplastral suture does not show in the figure.

about 120 degrees is provided for. When retraction of the neck is complete the lower surfaces of the two vertebræ are in contact with one another.

The characteristic feature of the skull is the three long processes, a median and two lateral, which project backwards from its hinder end. The former is produced by the supra-occipital bone, the latter chiefly by the squamosal. The temporal region is never roofed over as in the Marine Turtles; a temporal arch is constantly present, formed chiefly by the jugal.

All the Asiatic species of *Trionyx*, *Chitra*, *Pelochelys*, and *Dogania* possess three pairs of scent-glands. The axillary

and inguinal glands open on the flat under-surface of the disc, at the anterior and posterior margins respectively of the hyo- and hypoplastral bones. The humeral glands open on the margin of the dorsal disc above the middle of the fore-limb or internal to it. *Lissemys* has two pairs of glands only, humeral and inguinal, as have the American species of *Trionyx*.

The hyoid apparatus in the *Trionychidæ* is larger in proportion than in any other Chelonians. The body may be formed of three or four pairs of bones. Three appear to be constantly present in *Chitra*, *Pelochelys*, *Dogania*, and *Lissemys*, while *Trionyx* may have three or four. Siebenrock has shown (Ann. Naturh. Hofmus. Wien, xxvii, 1913, p. 221, fig.) that *T. euphraticus* has normally four pairs, and, as shown here,

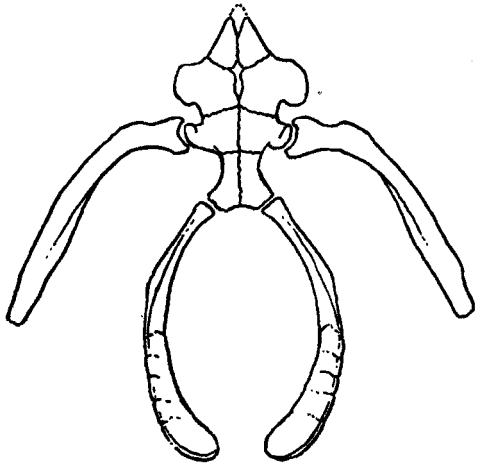

Fig. 33.—Hyoid apparatus of *Trionyx cartilagineus*.

four may be present in some specimens of *T. cartilagineus* and three only in others. I see no reason for separating, even subspecifically, the individuals that have three pairs from those that have four. Two large pairs of bony cornua are present, the hinder attached to the last pair of copulæ, and terminating in a series of additional ossifications.

A not uncommon abnormality in this genus is an upward curvature of the vertebral column so that the carapace, instead of being flat, is more or less humped. The presence of a deep groove on the middle line of the carapace is another common abnormality.

The Freshwater Turtles are thoroughly aquatic in their habits. They live chiefly in rivers, but are to be found also in canals, marshes, and ponds. Despite statements to the

contrary, I believe that all the species live in fresh water only and never enter the sea. *Trionyx* and its allies appear to be active throughout the year, unless, as sometimes happens, their habitat dries up, when they æstivate until set free by the rains. *Lissemys*, on the other hand, undergoes a period of hibernation, at any rate in the northern parts of its range; Annandale states that those which inhabit the Museum tank in Calcutta disappear for the whole of the cold weather, and that specimens have been dug up in February at Purulia, near Calcutta, from the mud at the bottom of dried-up ponds.

The *Trionychidæ* are mainly carnivorous, at any rate in a wild state, feeding largely upon fish, molluscs, frogs, etc.; but they are not particular whether their food is alive or dead, and in captivity will devour rice, bread, sweetmeats, and other vegetable food. In many of the Indian temples they are kept in a semi-domesticated state, and in such conditions they soon become tame and learn to come and feed when called.

The flesh of many species is eaten. According to Annandale, very large numbers are caught, chiefly in the Khulna District, for the Calcutta market, and are sent to town by train. They are captured in nets in the autumn, when the rivers begin to sink, and are stored in the vicinity of Calcutta in small ponds, their fore- and hind-feet being sewed together, and a hole, to which a string is attached, is bored in the cartilaginous part of the disc. In this condition they live for many months.

The species of *Trionyx* are fond of burying themselves in the mud of their habitat, leaving only the head and a small part of the back exposed, the colours of which harmonize well with their surroundings. Hidden thus they lie in wait for food to pass, seizing it with a sudden and rapid movement of the long neck as soon as it comes within reach. Not all their food is caught in this way, however. Much of it is found by hunting, for they are voracious creatures. The usual method of progression in the water is by alternate movements of the limbs, but if called upon to start suddenly, the fore-limbs may be moved together, being extended simultaneously towards the snout and then striking backwards. All the species are extremely active and quick in their movements when in the water. On land they are clumsy. The adults are powerful and vicious creatures and dangerous to handle, for they can inflict severe bites. Their long and flexible necks can reach to most parts of the body, and when catching them the only place that can be held with safety is the margin of the disc just in front of the hind-limbs. When the head and neck are withdrawn into the shell the loose skin rolls off from the greater part of it and assists in covering it. The skin of the legs also slips off, as far as the elbows and knees.

The exact distribution of the species included in this work

is still very incompletely known, in particular of those that occupy the rivers of Southern India and of Burma. No species of *Trionyx* has yet been recorded from Ceylon.

The preservation of large individuals for study purposes is almost impossible in the field. The most practical method is to put the head and limbs into strong spirit and to clean and dry the shell. A sketch showing the colours in life should also be made if possible.

An account of the worship of Mud Turtles in India and Burma has been given by Annandale and Shastri (J. & P. Asiat. Soc. Bengal (n. s.), x, 1914, p. 131).

Fossil *Trionyx*, *Chitra*, and *Lissemys* indistinguishable from present-day forms have been found in the Pliocene and Pleistocene of the Siwalik Hills of India.

Key to the Genera.

I. Plastron with a cutaneous femoral valve under which the hind-limb can be concealed ; marginal bones present ; seven plastral callosities in the adult ..... [p. 154. LISSEMYS,

II. Plastron without cutaneous femoral valves ; no marginal bones ; four plastral callosities in the adult.

A. All the costal plates separated on the median line by the neural plates ; head very large ; postorbital arch extremely narrow, its outer surface reduced to an edge ..... [p. 164. DOGANIA,

B. Last one or two pairs of costal plates in contact with each other on the mid-line ; head moderate or small ; postorbital arch not edged.

Orbit nearer the temporal than the nasal fossa ; postorbital arch narrower than the diameter of the orbit ; proboscis as long as the eye-opening . [p. 165. TRIONYX,

Orbit nearer the nasal than the temporal fossa ; postorbital arch a little broader than the diameter of the orbit ; proboscis very short, not more than half the length of the eye-opening.... [p. 160. PELOCHELYS,

Orbit nearer the nasal than the temporal fossa ; postorbital arch twice as broad as the diameter of the orbit ; proboscis as long as the eye-opening ..... CHITRA, p. 162.

Genus **LISSEMYS**, nom. nov.

Trionyx (in part) Geoffroy, Ann. Mus. Hist. Nat. Paris, xiv, 1809, p. 1 ; Stejneger, Science, N. York (n. s.), xxi, 1905, p. 228.

Emyda (not of Rafinesque, 1815) Gray, Syn. Rept. 1831, p. 49 (type *punctata*) ; Günther, Rept. Brit. Ind. 1864, p. 44 ; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 267 ; Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 590 ; Annandale, Rec. Ind. Mus. vii, 1912, p. 170.

Cryptopus (not of Latreille, 1829) (in part) Dum. & Bib., Erp. Gen. ii, 1835, p. 501 (type *Testudo granosa* Schoepff).

Nuchal bone butterfly-shaped; dorsal shield with a prenuchal marginal, and a series of posterior marginal, bony plates; seven or eight neural plates forming a continuous series; eight pairs of costal plates, the last two pairs forming a median suture. Plastron with a cutaneous femoral valve,

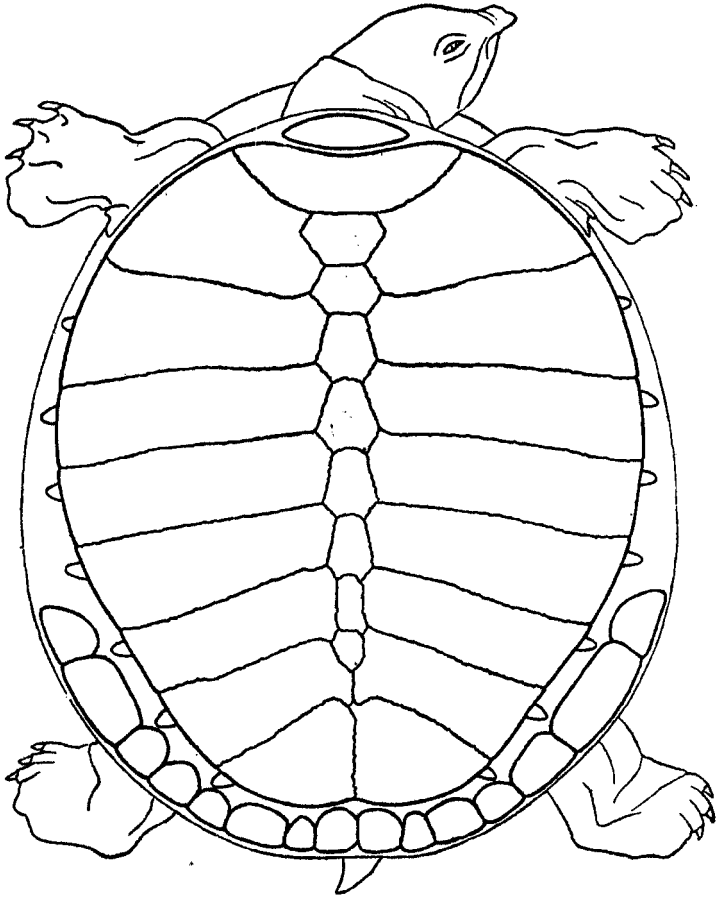

Fig. 34.—Dorsal view of *Lissemys punctata scutata.*

under which the hind-limb may be concealed; seven plastral callosities in the adult; hyoplastron co-ossified with hypoplastron. Skull convex above; postorbital arch narrower than the orbital diameter; posterior border of pterygoid with a median ascending process which forms a suture with the opisthotic. Tail very short.

A single species inhabiting India and Burma. Three subspecies are recognized.

Emyda Rafinesque 1815 was proposed as a substitute name for *Emys* Duméril 1806. It (*Emyda*) included all the Chelonians

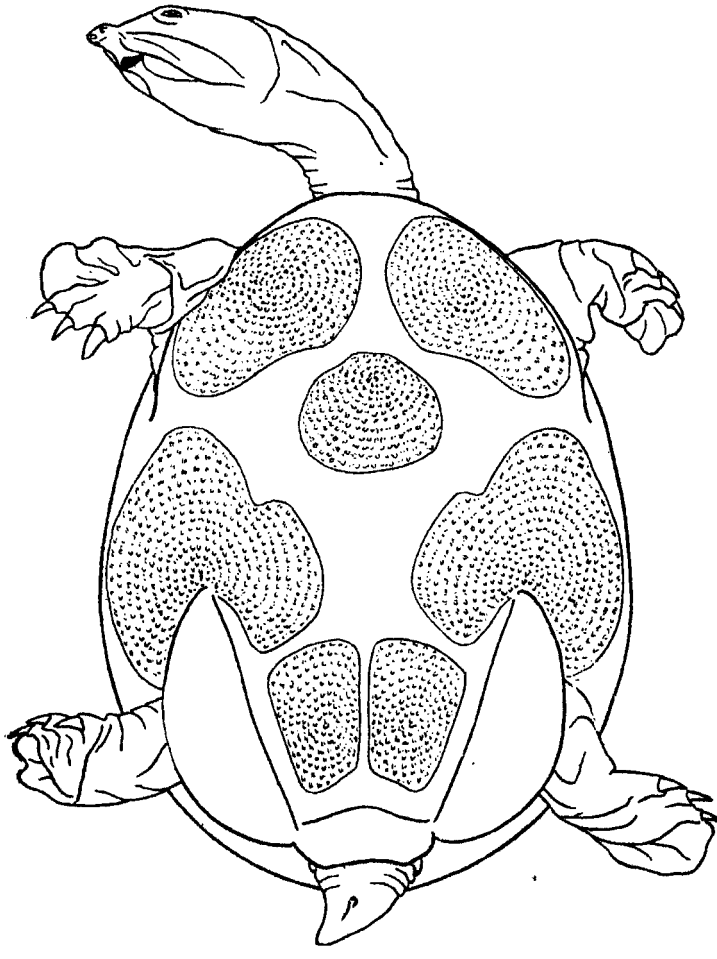

Fig. 35.—Ventral view of *Lissemys punctata granosa*.

with (five) movable, webbed toes, leaving the soft-shelled turtles with three toes under *Trionyx*, where they had been placed by Geoffroy in 1809. *Emyda* Gray is thus a homonym of *Emyda* Rafinesque, and cannot be used. The *Cryptopus*

of Duméril and Bibron 1835 is already occupied by *Cryptopus* Latreille 1829 for a genus of Crustacea. A new name is therefore needed for the genus long known as *Emyda*.

In *Lissemys* the ossification of the carapace is more extensive than in *Trionyx* and its allies, only the extreme tips of the ribs extending beyond the costal plates.

In addition to the characteristic flaps of the plastron under which the hind-limb may be hidden, the anterior lobe is hinged and capable of some movement. This takes place at the attachment of the epiplastra to the entoplastron, and it is perhaps to facilitate this movement that the posterior limbs of the epiplastra have disappeared. The anterior and posterior margins of the carapace can also be bent downwards so that the heads and limbs of the creature when retracted are completely hidden.

The marginal bones appear first as a number of separate ossifications, from eight to twelve in number on either side; in the Indian and Ceylonese races the anterior two or three normally fuse together to form a single plate, the fusion taking place at a comparatively early age. In the Burmese form this usually does not happen, and the distinction forms a good character for racial separation.

Lissemys inhabits ponds and tanks rather than rivers. It feeds upon both animal and vegetable matter, and is of a quiet and timid disposition.

Key to the Subspecies.

First marginal bone much larger than second in the adult; entoplastral callosity usually small in the adult; head and carapace with yellow spots ..... *L. punctata*, p. 157.

First marginal bone much larger than the second in the adult; entoplastral callosity moderate * in the adult; carapace uniform brown; head with black longitudinal streaks, at least in the young..... [p. 158. *L. punctata granosa*.

First marginal bone smaller than the second; entoplastral callosity very large in the adult; brown above, the carapace spotted or reticulated with black ..... [p. 159. *L. punctata scutata*.

46. **Lissemys punctata** (forma typica).

La Tortue chagrinée Lacepède, Hist. Quad. Ovip. i, 1788, p. 171, pl. xi.

Testudo punctata Bonnaterre, in Daubenton's Tab. Encycl. Méth., Erpet. 1789, p. 30, pl. 6 (type loc. "Les grandes Indes").—*Emyda punctata*, Gray, Syn. Rept. 1831, p. 49 (type loc. Ganges; Brit. Mus.); Bell, Monogr. Test. 1836, 2 pls.; Sowerby & Lear, Tort. Terr. etc. 1872, p. 12, pls. lv, lvi.—*Trionyx punctata*, Gray, Illus. Ind. Zool. ii, 1834, pl. 63 (juvenile).

* The figure of *Lissemys punctata granosa* shows a moderate callosity (fig. 35).

Trionyx granosus, (not of Schoepff), Gray, Illus. Ind. Zool. ii, 1834, pl. 64 (adult), and Ann. Mag. Nat. Hist. (4) x, 1872, p. 340.—*Emyda granosa*, (not of Schoepff), Boulenger, Cat. Chel. Brit. Mus. 1889, p. 269, and Fauna Brit. Ind. 1890, p. 17; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 591; Annandale, Rec. Ind. Mus. vii, 1912, pp. 171, 172, fig. (branchial skel.); Ingoldby, J Bombay Nat. Hist. Soc. xxix, 1923, p. 120.

Emyda dura Anderson, J. Linn. Soc., Zool. xii, 1876, p. 514 (based on Buchanan-Hamilton's sketch in the India Office).

Carapace and plastral callosities finely granulate; two neural plates between the first pair of costals; first marginal bone in the adult very large, much larger than the others; seven plastral callosities in the adult, namely paired hyo-hypo-, xiphi-, and epiplastral, and a single entoplastral, the latter usually small in size in the adult.

Head moderate; snout rather short and broad, its length less than the length of the eye-opening. Skin of dorsal disc of young longitudinally plaited.

Olive-brown above with largish well defined yellow spots. On the head they are fairly regular, namely, one on the snout, one between the eyes, a broad one passing backwards from the eye to the tympanic region, two above it on the temporal region sometimes united to form a V-shaped mark, one below the eye, and one at the angle of the mouth. In old individuals the spots tend to disappear. Below yellowish or whitish.

Length of carapace 230, breadth (across the middle) 170 mm.

Range. The Ganges and Indus and their tributaries. Ingoldby records it from near Tank, in the irrigation channels into which the Tank Zam splits up on reaching the plain of the Indus; the British Museum collection contains a specimen from Sikkim; it occurs also in Akyab and on Jergo I. off the coast of Arakan. It has not been recorded from Assam.

Of its habits, Annandale remarks (1912) that although it rarely leaves the ponds in which it lives, it is fond of sunning itself on logs or stones projecting from the water. It is extremely timid and difficult to approach.

46 *a*. Lissemys punctata granosa.

Testudo granosa Schoepff, Hist. Test. 1792, p. 127, pls. xxx A & B (type loc. Coromandel coast; Mus. Blochianum).

Testudo granulata Shaw, Gen. Zool. iii, 1802, p. 68.

Trionyx coromandelicus Geoffroy, Ann. Mus. Hist. Nat. Paris, xiv, 1809, p. 16, pl. v.

Emyda vittata Peters, Monatsber. Akad. Berlin, 1854, p. 216 (type loc. Goa; Zool. Mus. Berlin); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 269, and Fauna Brit. Ind. 1890, p. 18.—*Emyda granosa vittata*, Annandale, Rec. Ind. Mus. vii, 1912, pp. 172, 173; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 591.

Emyda ceylonensis Gray, Cat. Sh. Rept. 1855, p. 64, pl. xxix A (type loc. Ceylon ; Brit. Mus.).—*Emyda granosa ceylonensis*, Annandale, Rec. Ind. Mus. vii, 1912, pp. 172, 173 ; Deraniyagala, Ceylon J. Sc., Sect. B, xvi, 1930, p. 56, pl. 10.

Emyda granosa intermedia Annandale, ibid. pp. 172, 176, pl. vi and p. 264 (type loc. Purulia, Manbhum Dist., C.P. ; Ind. Mus.), and id. ix. 1913, p. 77.

Differs from the typical form in having the entoplastral callosity usually moderate in size in the adult, and in coloration. The carapace is uniform olive-brown or may have obscure pale markings in the young ; the head is greenish, with three oblique, parallel, black streaks (the middle one behind the eye), in the young. These may or may not disappear with age.

Size as in the typical form.

Range. The Indian Peninsula south of the Ganges, and Ceylon. The Barakar, Kasai, Mahanadi, and Godavari Rivers ; the Madras Presidency, occurring in the hills up to 1000 metres altitude as well as at sea-level ; the Bombay Presidency, including Cutch. There is a specimen in the collection of the Bombay Natural History Society from Jhansi. Annandale's *E. g. intermedia* ranges, according to him, through Chota Nagpur, the Central Provinces, Orissa, and the north-eastern part of the Madras Presidency. It differs from his *vittata*, which he confines to the Madras and Bombay Presidencies, and from *ceylonensis*, in that the carapace of the young has obscure pale markings, whereas *vittata* and *ceylonensis* have not. All three forms, however, maintain the black head streaks, and, in the absence of other characters by which to distinguish them, I prefer to combine them all under one name.

In Ceylon *L. p. granosa* is generally distributed at low altitudes, being found chiefly in ponds and tanks. Deraniyagala states that it is very destructive to fish, and at night wanders ashore in search of other food. When caught it bites savagely and suddenly. Ten or twelve eggs are laid at one time, being buried in the ground close to the water. They measure 30 to 33 mm. in diameter.

46 *b*. Lissemys punctata scutata.

Emyda scutata Peters, Monatsber. Akad. Berlin, 1868, p. 449 (type loc. Pegu; Zool. Mus., Berlin); Anderson, Zool. Res. W. Yunnan, 1879, p. 779, pls. lxxiv, lxxv, lxxv A ; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 270, and Fauna Brit. Ind. 1890, p. 18 ; Siebenrock, Zool. Jahrb. Jena, 1909, Suppl. 10, p. 592.—*E. granosa scutata*, Annandale, Rec. Ind. Mus. vii, 1912, p. 173.

Emyda fuscomaculata Gray, Ann. Mag. Nat. Hist. (4) xi, 1873, p. 308 (type loc. Pegu ; Brit. Mus.).

Differs from the typical form in having the first marginal bone smaller than the second, in the very large entoplastral

callosity in the adult (in extreme cases it is in contact with the hyo-hypoplastral callosities) and in coloration. The carapace is olive-brown, with indistinct dark spots in the young which tend to form a dark reticulation in the adult. An indistinct dark stripe passing backwards from the eye and another between the eyes may be present.

Size as in the typical form.

Range. The Irrawaddy and Salween Rivers; not uncommon in Pegu. The female lays her eggs in December, scraping a hole for them in the mud and then covering them up. They measure about 25 mm. in diameter.

Genus PELOCHELYS.

Pelochelys Gray, Proc. Zool. Soc. 1864, p. 89 (type *cantorii*); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 262, and Fauna Brit. Ind. 1890, p. 15.

Outer extremity of nuchal plate overlying the second dorsal rib; seven or eight neural plates forming a continuous series; eight pairs of costal plates, the last one or two pairs in contact in the mid-line. Hyoplastron distinct from hypoplastron. Skull broad, flat above; postorbital arch a little broader than the diameter of the orbit; posterior border of pterygoid free, without ascending process. Limbs exposed. Tail very short. A single species.

47. Pelochelys bibroni.

Trionyx (*Gymnopus*) *bibroni* Owen, Cat. Osteol. Ser. R. Coll. Surg. i, 1853, p. 185 (type loc. "Australia"; Coll. Surg.); M. A. Smith, Bull. Raffles Mus. Singapore, No. 3, 1930, p. 3.

Chitra indica (in part) Günther, Rept. Brit. Ind. 1864, p. 50, pl. vi.

Pelochelys cantorii Gray, Proc. Zool. Soc. 1864, p. 90, figs. (type loc. Malacca; Brit. Mus.); Annandale, Rec. Ind. Mus. vii, 1912, p. 168; Schmidt, Bull. Amer. Mus. Nat. Hist. liv, 1927, p. 409, figs.; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 607.—*P. cantoris*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 262, and Fauna Brit. Ind. 1890, p. 15; Mell, Arch. Naturg. Berlin, vol. lxxxviii (10) 1922, p. 110.

Pelochelys poljakowii Strauch, Mem. Acad. Sc. St. Pétersb. xxxviii (7) 1890, p. 118 (type loc. Fuchow, China; Zool. Mus. St. Pétersb.).

Pelochelys cummingii Gray, Proc. Zool. Soc. 1864, p. 90 (type loc. Philippine Is.; Brit. Mus.).

A single neural plate between the first pair of costals; all the plates of the carapace coarsely pitted and vermiculate. Anterior limbs of epiplastra rather short and broad, widely separated from one another; four well developed plastral callosities, hyo-hypoplastral and xiphiplastral, in the adult. Head rather small, broad; snout short, rounded; proboscis very short, a mere projection.

Olive above, dotted all over with yellow; whitish below.

Length of dorsal disc 600 mm.

Range. ? Bengal ; the Indo-Chinese Peninsula and Southern China ; Hainan ; ? the Malay Peninsula ; Sumatra ; Borneo ; the Philippine Islands ; New Guinea. It is the most widely distributed of all the Freshwater Turtles.

Its occurrence in Bengal is doubtful. Annandale (1912) states that he has never seen one alive himself, but that there is a specimen in the Indian Museum obtained by Anderson labelled Calcutta. It is evidently rare in Burma ; the British Museum collection has two examples, one said to be from

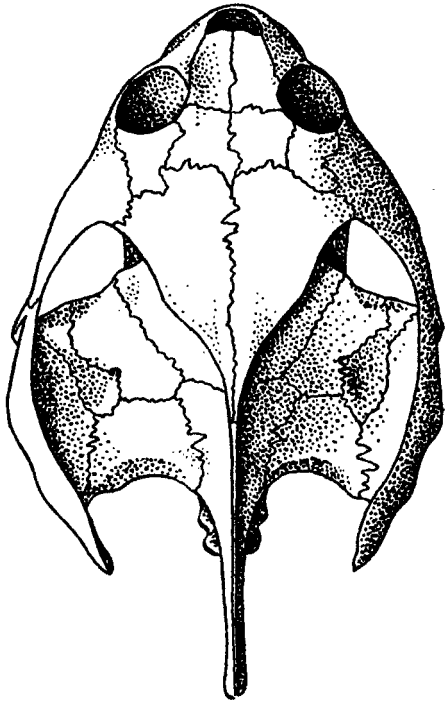

Fig. 36.—Skull of *Pelochelys bibroni*.

Akyab. I have seen four specimens from Central Siam. Cantor's type, said to have come from Malacca, is the only known example from the Malay Peninsula.

Pelochelys bibroni in Siam inhabits deep and slow-flowing rivers, always, as far as I am aware, above the limits of salt water. Its flesh is eaten by the people.

All the specimens that I have examined from Burma, Siam, and the Philippine Islands have seven neural plates and the

last two pairs of costals in contact with one another; those from the Malay Peninsula (?) and the East Indian Archipelago (New Guinea) have eight neural plates and the last pair of costal plates in contact with one another. The figure of *P. poljakowii* from China agrees with the Malayan form, and the specimen recorded by Schmidt (1927) from Hainan has also eight neurals *.

Günther's figure (1864) represents a *P. bibroni*, but with the markings of *Chitra indica*.

Genus **CHITRA**.

Gymnopus (in part) Dum. & Bib., Erp. Gen. ii, 1835, p. 472 (subst. name for *Trionyx*).
Chitra Gray, Cat. Tort., etc., Brit. Mus. 1844, p. 49 (type *Trionyx indicus*); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 263, and Fauna Brit. Ind. 1890, p. 16.

Outer extremity of nuchal plate overlying the second dorsal rib; eight neural plates forming a continuous series; eight pairs of costal plates, the last pair in contact in the mid-line. Hyoplastron distinct from hypoplastron; skull long and narrow, flat above, the orbits close to its anterior extremity; postorbital arch twice as broad as the diameter of the orbit; posterior border of pterygoid free, without ascending process. Limbs exposed. Tail very short. A single species.

An example from Siam has only seven neural plates, and the last two pairs of costal plates in contact with one another.

48. **Chitra indica.**

Trionyx indicus Gray, Syn. Rept. 1831, p. 47, and *T. ægyptiacus* var. *indica* in Illus. Ind. Zool. vol. i, pl. 80, 1831 (type loc. Fatehgarh, Ganges), and Cat. Sh. Rept. i, 1855, pl. xli, fig. (skull).—*Chitra indica* (in part), Günther, Rept. Brit. Ind. 1864, p. 50, pl. vi.—*Chitra indica*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 264, fig. (skull), and Fauna Brit. Ind. 1890, p. 16; Annandale, Rec. Ind. Mus. vii, 1912, p. 169, pls. vi & xi, 1915, p. 347; Parshad, ibid. x, 1914, p. 268; M. A. Smith, J. Fed. Malay St. Mus. x, 1922, p. 264.
Gymnopus lineatus Dum. & Bib., Erp. Gen. ii, 1835, p. 491.

A single neural plate between the first pair of costals; all the plates of the carapace coarsely pitted and vermiculate; anterior limbs of epiplastra long and slender, widely separated from one another; four well developed plastral callosities, hyo-hypoplastral and xiphiplastral, in the adult. Head rather small, elongate; snout rounded. Proboscis about as long as the eye-opening.

Disc dull olive above, with dark vermiculations or black punctate spots in the young, with splashes and large angular markings of pale yellowish in the adult. Head and neck with light, black-edged longitudinal streaks and a Λ-shaped mark

* On information supplied me by Mr. Clifford Pope.

in the mid-line commencing just in front of the disc. With age the markings grow less distinct. Günther's figure (1864) is a *Pelochelys bibroni* with the markings of *Chitra indica*.

Length of dorsal disc about 800 mm. The largest of the Indian Trionychids.

Range. Northern India; Siam; the Malay Peninsula.

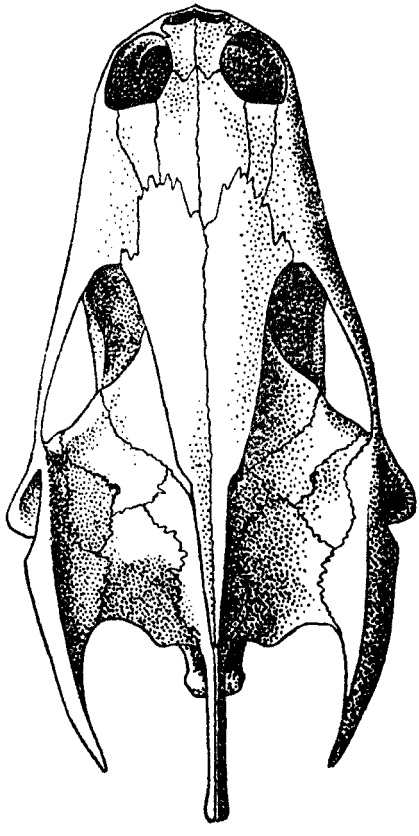

Fig. 37.- Skull of *Chitra indica*.

Parshad records it from the Sutlej River, a tributary of the Indus. Falconer obtained it in Nepal; Annandale (1912) states that it is not uncommon in the Gangetic delta, and can often be bought in the Calcutta market. It is said to inhabit the Irrawaddy, but I cannot trace any specimen having been obtained there.

I have seen three examples from Siam. They were caught

on the upper reaches of the Ratburi River, where the waters are clear and the banks sandy. Robinson and Kloss obtained a specimen at the foot of Gunong Tahan in the Malay Peninsula.

Chitra indica feeds upon fish, molluscs, and other animal food. It is a dangerous creature to handle, as it will suddenly shoot out its long neck with inconceivable rapidity and is capable of giving a very severe bite.

The original coloured sketches upon which this species was based are in the British Museum (Natural History) (Hardwicke Coll., Nos. 31 & 40).

Genus **DOGANIA.**

Dogania Gray, Cat. Tort., etc., Brit. Mus. 1844, p. 49 (type *Trionyx subplanus*).

Sarbiera Gray, Proc. Zool. Soc. 1869, p. 220 (type *Trionyx frenatus*).

Outer extremity of nuchal plate overlying the second dorsal rib; eight neural and eight costal plates, all the latter separated from one another by the neurals. Hyoplastron distinct from hypoplastron; head large; skull convex above; postorbital arch extremely narrow, its outer margin reduced to an edge; posterior border of pterygoid free, without ascending process. Limbs exposed. Tail short. A single species.

49. **Dogania subplana.**

Trionyx subplanus Geoffroy, Ann. Mus. Hist. Nat. Paris, xvi, 1809, p. 11, pl. v (type loc. unknown; Paris Mus. Nat. Hist.); Gray, Illus. Ind. Zool. i, 1832, pl. 79.—Boulenger, Cat. Chel. Brit. Mus. 1889, p. 246, fig., and Fauna Brit. Ind. 1890, p. 11; Flower, Proc. Zool. Soc. 1899, p. 619, pl. 36.—*Dogania subplana*, Gray, Cat. Sh. Rept. i, 1855, p. 69, pl. 33, and Proc. Zool. Soc. 1873, p. 57, fig.; Annandale, Rec. Ind. Mus. vii, 1912, p. 154.

Trionyx frenatus Gray, Cat. Sh. Rept. i, 1855, p. 67 (type loc. Singapore; Brit. Mus.).

Dogania guntheri Gray, Proc. Zool. Soc. 1862, p. 265 (type loc. "India"; Brit. Mus.).

Trionyx ? dillwynii Gray, Ann. Mag. Nat. Hist. (4) xi, 1873, p. 306 (type loc. Borneo; Brit. Mus.).

Carapace flat; disc elongate, considerably longer than broad. A single neural plate between the first pair of costals; all the plates of the carapace finely pitted and vermiculate. Anterior limbs of epiplastra long and slender, nearly touching one another in front of the entoplastron; four plastral callosites, hyo-hypoplastral and xiphiplastral, feebly developed in the adult, often absent. Head very large; snout (on the skull) at least as long as the orbit, twice the interorbital width. Proboscis about as long as the opening of the eye.

Disc olive-brown above, uniform or with a fine yellow

mottling; a more or less distinct black vertebral stripe, and two, sometimes three, pairs of black ocellar spots; whitish below (pale yellow in life). Head and limbs olive-brown above; a dark median streak on the neck starting from between the eyes and two oblique streaks on either side, the upper pair meeting each other between the eyes; chin with black vermiculations.

Length of dorsal disc 250 mm.

Range. Burma; Siam; the Malay Peninsula and Archipelago; the Philippine Islands. Annandale gives its range as far north as Arakan; the only Burmese specimens that I know of were obtained in Mergui.

D. subplana is fairly common in some parts of the Malay Peninsula and Archipelago: it is found on many of the small islands where other Trionychids are never found. It appears to prefer hill streams rather than slow-flowing muddy-bottomed rivers, hiding itself away beneath rocks and large stones, for which purpose its flattened shell is admirably suited. I doubt Annandale's statement (*fide* H. C. Robinson) that it is an estuarine and marine species.

Genus **TRIONYX.**

Trionyx (in part) Geoffroy, Ann. Mus. Hist. Nat. Paris, xiv, 1809, pp. 4, 20 (type *Trionyx ægyptiacus*); (in part) Boulenger, Cat. Chel. Brit. Mus. 1889, p. 242, and Fauna Brit. Ind. 1890, p. 10; Siebenrock, SB. Akad. Wiss. Wien, xci (1) 1902, p. 815, and Zool. Jahrb. Jena, Suppl. 10, 1909, p. 595; Annandale, Rec. Ind. Mus. vii, 1912, p. 154; M. A. Smith, Bull. Raffles Mus. Singapore, No. 3, 1930, p. 2.

Amyda Oken, Lehrb. Zool. ii, 1816, p. 348 (type *T. euphraticus*); Stejneger, Herpet. Japan, 1907, p. 514.

Aspidonectes Wagler, Syst. Nat. 1830, p. 134 (type *T. ægyptiacus*).

Gymnopus Dum. & Bib., Erp. Gen. ii, 1835, p. 472 (subst. name for *Aspidonectes*).

Pelodiscus Fitzinger, Ann. Wien. Mus. i, 1835, pp. 120, 127 (type *T. sinensis*).

Potamochelys Fitzinger, Syst. Rept. 1843 (type *T. javanicus*).

Tyrse Gray, Cat. Tort. etc. Brit. Mus. 1844, p. 47 (type *T. nilotica*).

Rafetus Gray, Proc. Zool. Soc. 1864, p. 81 (type *T. euphraticus*).

Aspilus Gray, ibid. 1864, p. 83 (type *T. cariniferus*).

Landemania Gray, ibid. 1869, p. 215 (type *T. irrorata*).

Fordia Gray, ibid. 1869, p. 219 (type *africana*).

Isola Gray, ibid. 1873, p. 51 (type *peguensis*).

Ida Gray, ibid. 1873, p. 51 (type *ornata*).

Oscaria Gray, Ann. Mag. Nat. Hist. (4) xii, 1873, p. 157 (type *swinhoei*).

Yuen (type *leprosus*), *Psilognathus* (type *lævis*), *Temnognathus* (type *mordax*), *Gomphopelta* (type *officinæ*), *Cœlognathus* (not of Hessling, 1852) (type *novemcostatus*), *Tortisternum* (type *novemcostatum*), *Ceramopelta* (type *latirostris*), *Coptopelta* (type *septemcostata*), *Cinctisternum* (type *bicinctum*) Heude, Mem. Hist. Nat. Emp. Chinois, 1880, pp. 18–36.

The above synonymy applies to the Old World species. They have normally eight pairs of costal plates, and thereby

differ from the American species, which have normally only seven pairs.

Outer extremity of nuchal plate overlying the second dorsal rib; normally eight neural and eight dorsal plates, the last one or two of the latter in contact in the mid-line. Hyoplastron distinct from hypoplastron; not more than five plastral callosities in the adult. Skull convex above; post-orbital arch narrower than the orbital diameter; posterior border of pterygoid free, without ascending process. Limbs exposed. Tail short or very short. Proboscis about as long as the opening of the eye. Dorsal disc of the young with small tubercles, mostly arranged in longitudinal series.

About 15 species are known. 10 of which are Asiatic, one African, and the others North American.

Key to the Species.

A. Two neural plates between the first pair of costals.

Alveolar surface of mandible raised at its inner margin, the edges meeting and forming a projection at the symphysis, the length of which is less than the diameter of the orbit in the adult; maxillary groove well defined; head with black streaks; disc of young without ocelli .... [p. 167. *gangeticus*.

Alveolar surface of mandible not raised at its inner margin; a longitudinal ridge at the symphysis, the length of which equals the orbital diameter; maxillary groove well defined; head blackish; young not known ..... [p. 168 *nigricans*,

Alveolar surface of mandible not raised at its inner margin, more or less flat at the symphysis, which is usually longer than the orbital diameter in the adult; maxillary groove well defined; head with black streaks, disc of young with 4 or more ocelli ..... *leithi*, p. 170.

Alveolar surface of mandible not raised at its inner margin, grooved at the symphysis, which is distinctly longer than the diameter of the orbit in the adult; maxillary groove ill defined; head marbled with black and yellow; disc of young with 4 or more ocelli ..... *hurum*, p. 171.

B. A single neural plate between the first pair of costals.

I. Alveolar surface of mandible with a longitudinal symphysial ridge.

Snout (on the skull) not longer than the diameter of the orbit *; epiplastra widely separated from one another; young with large (paired) ocellar spots. *formosus*, p. 173.

Snout (on the skull) longer than the diameter of the orbit *; epiplastra in contact with, or narrowly separated from, one another; young usually with irregularly disposed black stellate spots ..... [p. 174. *cartilagineus*,

* Measured along the edge of the jaw from a point level with the anterior margin of the orbit.

II. Alveolar surface of mandible without longitudinal symphysial ridge.
Length of mandibular symphysis greater than the diameter of the orbit ..... *sinensis*, p. 176.
Length of mandibular symphysis less than the diameter of the orbit ..... *steindachneri*, p. 178.

50. **Trionyx gangeticus.** (Plate II, fig. 7.)

Trionyx gangeticus Cuvier, Oss. Foss. v, 1824, pp. 186, 203, 206, pls. xi, xii (type loc. Ganges ; Paris Mus. Nat. Hist.) ; Gray, Cat. Sh. Rept. 1855, pl. xlii (skull) ; Anderson, Ann. Mag. Nat. Hist. (4) ix, 1872, p. 382 ; Theobald, Proc. Asiat. Soc. Bengal, 1874, p. 78 ; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 248, and Fauna Brit. Ind. 1890, p. 12 ; Siebenrock, Zool. Jahrb. Jena, Suppl. 10, 1909, p. 596 ; Annandale, Rec. Ind. Mus. vii. 1912, p. 157, fig. (lower jaw) ; Parshad, ibid. x, 1914, p. 267 ; Ingoldby, J. Bombay Nat. Hist. Soc. xxix, 1923, p. 120.

Trionyx javanicus (not of Geoffroy). Gray, Illus. Ind. Zool. ii, 1834, pl. 66 ; Anderson, Ann. Mag. Nat. Hist. (4) ix, 1872, p. 382.

Gymnopus duvaucelli Dum. & Bib., Erp. Gen. ii, 1835, p. 487 (type loc. Ganges ; Paris Mus. Nat. Hist.).

Potamochelys stellatus Gray, Proc. Zool. Soc. 1864, p. 85, fig. (skull) (type loc. India).

Aspilus gataghol Gray, Ann. Mag. Nat. Hist. (4) x, 1872, p. 339 (based on Hamilton's fig. of T. *javanicus* in Illus. Ind. Zool. ii, 1834, pl. 65).

Trionyx gangeticus mahanaddicus Annandale, Rec. Ind. Mus. vii, 1912, p. 262 (type loc. Cuttack, Orissa ; Ind. Mus.), and xi, 1915, p. 342, fig. (head).

Two neural plates between the first pair of costals ; costal plates well developed, usually the last two pairs in contact in the mid-line ; all the plates of the carapace coarsely pitted and vermiculate ; anterior limbs of epiplastra long and slender, in contact with or narrowly separated from one another ; four plastral callosities, hyo-hypoplastral and xiphiplastral, well developed in the adult, in old individuals sometimes a fifth upon the entoplastron.

Skull. Snout as long as the diameter of the orbit ; post-orbital arch one-half to one-third the diameter of the orbit ; alveolar surfaces of upper jaw flat, with a well defined median (maxillary) groove between them ; mandible with raised inner edges, which meet at the symphysis to form a short, median projection ; length of symphysis less than the diameter of the orbit in the adult.

Disc olive-green above, with fine black reticulations in the young, without ocelli ; sometimes vermiculated with yellowish in the adult. Head greenish, with a black longitudinal streak from between the eyes on to the nape and three oblique black streaks on either side diverging from it ; another streak starting from behind the eye. These markings may be broken up and only parts of them visible, and in old individuals may be entirely lost ; below whitish.

Length of dorsal disc 700 mm.

Range. The Indus, Ganges and Mahanadi and their tributaries. It is common in Dera Ismail Khan, North-West Frontier Province (Ingoldby, 1923), and occurs also in the neighbourhood of Karachi. Its range extends north to the base of the Nepal foot-hills. It is common in Lower Bengal, considerable numbers being brought into the Calcutta market and sold for food.

I cannot agree with Annandale that the skull of *T. g. mahanaddicus* differs from that of the typical form. The coloration of the head is somewhat different in that the whole of the

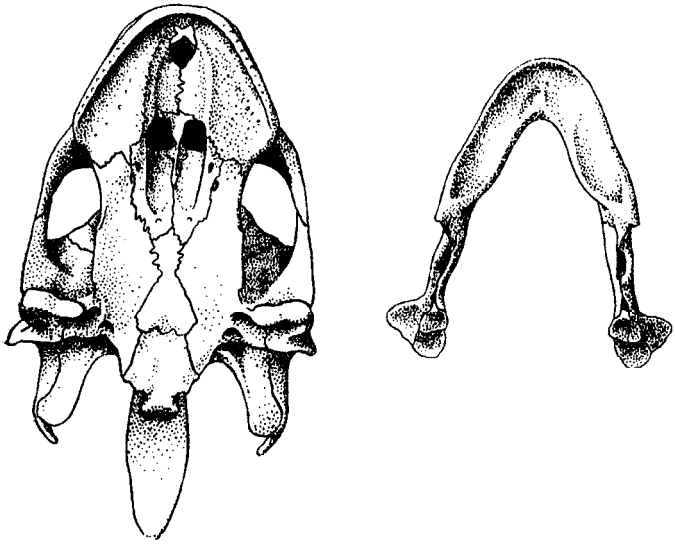

Fig. 38.—Skull of *Trionyx gangeticus*.

upper part and sides of the head are marbled with dark olive, but the characteristic dark streaks of *gangeticus* are present, although obscured in outline by light vermiculations.

51. Trionyx nigricans.

Trionyx nigricans Anderson, Ann. Mag. Nat. Hist. (4) xvi, 1875, p. 284 (type loc. Chittagong Tanks ; Ind. Mus.) ; Annandale, Rec. Ind. Mus. vii, 1912, p. 164, fig. (mandible), and J. & P. Asiatic Soc. Bengal, (n. s.) x, 1914, p. 132.

Carapace and plastron as in *T. gangeticus*.

Skull. Snout a little longer than the diameter of the orbit ; postorbital arch one half or less the diameter of the orbit ; alveolar surfaces of upper jaw flat, with a well defined median

(maxillary) groove between them; inner edge of mandible not raised; symphysis with a prominent longitudinal ridge; length of symphysis about equal to the orbital diameter in the adult.

Anderson gives the coloration of the adult as follows:—"Carapace dark blackish plumbeous, with a tinge of olive due to the presence of blackish spots, among which are intermixed many rusty brown spots, which overlie as it were the black spots. The head, neck, and upper surface of the limbs are almost black; the upper lip in its two posterior thirds is white; and there is a great white blotch over the ear. The area between the neck and the forelegs is whitish; and there are some white spots on the margin of the carapace. The head is reticulately spotted; and there is a distinct infrapræorbital band, and a trace of another above the eyes; but the head is so black that these markings are difficult to distinguish. The under surface of the head and neck is almost black; and the plastron is densely spotted with blackish purple, especially over the bones, and the tail is similarly marked. The claws are yellow."

Annandale gives the coloration of living specimens as follows:—"Carapace copper brown indistinctly marbled with a darker shade; head and limbs apparently dark clay colour, but always covered with mud; top and sides of head bright glaucous green, taking a yellowish tinge above the eyes and nostrils and boldly reticulated with black or dark green; in all very old turtles the coloration of the head might be described as black with greenish spots which tend to disappear altogether with age." According to him the white blotches on the head and limbs are due to disease or injury. He states also that a small specimen seen by him (carapace rather over a foot long) "was diversified above with black and yellow vermiculations; it bore traces of four large blackish ocelli with pale margins."

Length of dorsal disc about 800 mm.

T. nigricans is only known from the Chittagong Tanks, where it is kept in a state of semi-captivity. There is a specimen in the Indian Museum labelled Calcutta, but it was probably never caught there.

Annandale, who visited the Mahommedan shrine where these turtles are kept, has left an interesting account of them:—"They live in a large pond attached to the shrine of Sultan Bagu Bastan (a saint who is said to have lived in the eighteenth century), about five miles from the town of Chittagong. The Mahommedans will neither kill them nor permit them to be killed; they believe they are in some way connected with the saint. The tank is surrounded by steps leading down to a platform a few inches under water, and the turtles are so tame that

they come to feed when called, placing their fore-feet on the edge of the platform or even climbing upon it and stretching their necks out of the water. The largest are tamer than the smaller ones. Some even allowed us to touch them, and ate pieces of chicken from wooden skewers held in our hands. The only sound they emitted was a low hiss. When undisturbed they remained at the bottom of the pond half buried in the mud. A man connected with the shrine told us that they left the water every evening and climbed a small hill, on which they slept. He said that they laid their eggs in the same hill during the rains."

52. **Trionyx leithi.**

Trionyx leithii Gray, Ann. Mag. Nat. Hist. (4) x, 1872, p. 334 (type loc. Poona ; Brit. Mus.) ; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 249, and Fauna Brit. Ind. 1890, p. 12 ; Annandale, Rec. Ind. Mus. vii, 1912, pp. 159, figs. and 264 ; ibid. xi, 1915, pp. 189, fig. (head) and 343.

Trionyx gangeticus, Gray, Proc. Zool. Soc. 1873, pl. viii.

Trionyx sulcifrons Annandale, Rec. Ind. Mus. xi, 1915, p. 341, fig. (head) (type loc. Nagpur ; Ind. Mus.).

Carapace and plastron as in *T. gangeticus*.

Skull. Snout longer than the diameter of the orbit ; post-orbital arch one-half to one-third the diameter of the orbit ; alveolar surfaces of upper jaw flat, with a fairly well defined median (maxillary) groove between them ; inner edge of mandible not raised ; symphysis more or less flat, its length equal to or greater than the diameter of the orbit in the adult.

Disc dark olive-green above with lighter vermiculations ; in the young it is more grey in colour and marked with four well defined ocelli ; a posterior pair or an additional one or two ocelli on other parts of the disc are sometimes present. Head greenish, with a more or less defined black longitudinal streak from between the eyes on to the nape and two or three oblique black streaks diverging from it on either side ; another streak starting behind the eye. These markings may be broken up and only portions of them present. Below whitish.

Length of dorsal disc 490 mm.

Range. The Ganges and rivers of Peninsular India as far south as Madras ; not definitely recorded from the Indus or its tributaries.

Gray's figures in Proc. Zool. Soc. 1873 are taken from the Hardwicke collection of drawings, Nos. 37, 38.

I cannot separate *T. sulcifrons* Annandale from this species. The grooves between the eyes, upon which the specific name is based, are to be found in a more or less marked degree in many species of *Trionyx*. The skull and skin of the head of the type, which I have examined, agree well with *T. leithi*.

53. Trionyx hurum.

Trionyx hurum Gray, Syn. Rept. 1831, p. 47, pl. x, based on Hamilton's drawing in Brit. Mus. (type loc. Fatehgarh, Ganges), and Illus. Ind. Zool. ii, 1834, pl. 66 ; Anderson, Ann. Mag. Nat. Hist. (4) ix, 1872, p. 383 ; Gray, ibid. (4) x, 1872, p. 336 ; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 249, and Fauna Brit. Ind. 1890, p. 49, fig. ; Annandale, Rec. Ind. Mus. vii, 1912, p. 160, figs. ; ibid. xi, 1915, p. 191.

Trionyx ocellatus Gray, Illus. Ind. Zool. i, 1832, pl. 78 (type loc. India ; based on Buchanan-Hamilton's drawing in the India Office) ; Theobald, Proc. Asiat. Soc. Bengal, 1875, p. 174, pl. iv.

Trionyx gangeticus, Sowerby & Lear, Tort. & Turt. 1872, pl. li.

Trionyx sewaare Gray, Ann. Mag. Nat. Hist. (4) x, 1872, p. 336 (based on Hamilton's drawing in Brit. Mus. Nat. Hist. ; type loc. Ganges).

Trionyx bellii Gray, Ann. Mag. Nat. Hist. (4) x, 1872, p. 337 (based on Bell's fig. of *T. gangeticus* in Sowerby & Lear).

Trionyx buchanani Theobald, Proc. Asiat. Soc. Bengal, 1874, p. 78 (type loc. Bengal ; Ind. Mus.).

Carapace and plastron as in *T. gangeticus*.

Skull. Snout longer than the diameter of the orbit, projecting more strongly downwards than in the three preceding

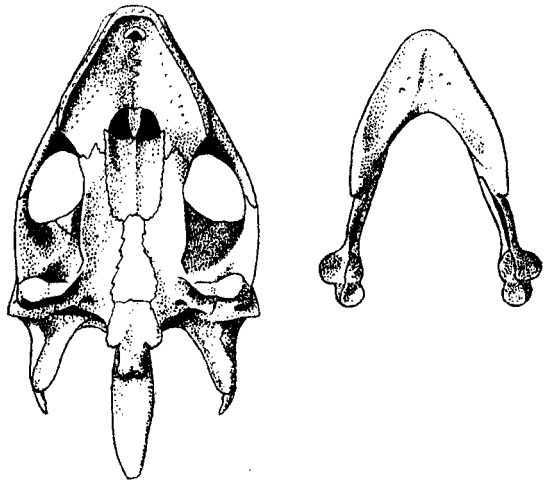

Fig. 39.—Skull of *Trionyx hurum*.

species ; postorbital arch one-half to one-third the diameter of the orbit ; alveolar surfaces of upper jaw sloping gradually to meet the median (maxillary) groove ; mandible produced at the symphysis, with a median groove on its inner surface ; the length of the symphysis considerably exceeds the diameter of the orbit.

Disc in the young dark olive-green above, with black reticulations, sometimes a margin of yellow dots and four

(rarely five or six) well defined ocelli. Head marbled with dark green or black lines and with large yellow spots, viz.

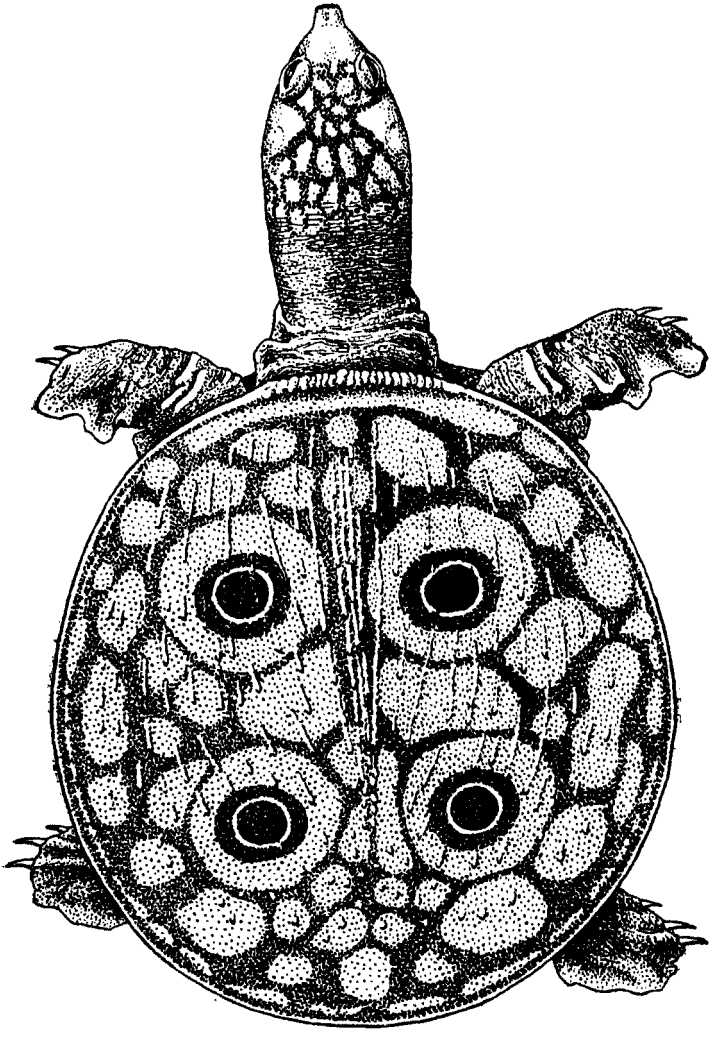

Fig. 40.—*Trionyx hurum*, juvenile.

across the snout, behind the orbit, at the angle of the mouth and behind it, and on the chin ; below brownish-grey. With age the dorsal disc becomes darker, the ocelli almost disappear,

the black marbling upon the head becomes more pronounced, but the yellow spots less distinct; the under surface becomes paler.

Length of dorsal disc 600 mm.

Range. The lower reaches of the Ganges and Brahmaputra; the evidence for its occurrence in the Malayan region is insufficient.

54. Trionyx formosus.

Trionyx formosus Gray, Proc. Zool. Soc. 1869, p. 217, pl. xv (type loc. Pegu; Brit. Mus.); Theobald, Cat. Rept. Brit. Ind. 1876, p. 31; Boulenger, Cat. Chel. Brit. Mus. 1889, p. 250, and Fauna Brit. Ind. 1890, p. 14; Annandale, Rec. Ind. Mus. vii, 1912, p. 167, fig. (mandible).

Trionyx peguensis Gray, Cat. Sh. Rept., Suppl. 1870, p. 99 (type loc. Toungoo, Burma; Brit. Mus.); Theobald, Cat. Rept. Brit. Ind. 1876, p. 31; Anderson, Zool. Res. W. Yunnan, 1879, p. 786, col. pls. lxx–lxxiii.

Trionyx grayi Theobald, Proc. Asiat. Soc. Bengal, 1875, p. 176, pl. 3 (type loc. near Thayetmyo, Burma; Brit. Mus.), and Cat. Rept. Brit. Ind. 1876, p. 31.

A single neural plate between the first pair of costals; costal plates well developed, the last pair in contact in the mid-line; all the plates of the carapace pitted and vermiculate; anterior limbs of epiplastra moderately long and slender, separated from one another; four plastral callosities, hyo-hypoplastral and xiphiplastral, well developed in the adult.

Skull. Snout equal to or less than the diameter of the orbit; postorbital arch one-half to one-third the diameter of the orbit; alveolar surface of mandible with a longitudinal ridge at the symphysis.

Dorsal disc in the young dark olive-grey, with black reticulations and two pairs of large black-centred ocelli; greyish below. Head and neck ornamented with yellowish dark-edged spots, an elongated one on either side at the back of the head and smaller ones on the temple, at the angle of the mouth, and on the chin. The adult is without these markings, the head being yellow, with black reticulations or punctate markings above and on the sides; the dorsal disc is densely marked with small black spots and four large, rounded, obscure black areas, the last traces of the beautiful ocelli of the young.

Length of dorsal disc 380 mm.

Range. Burma; the Irrawaddy, Sittang, and Salween Rivers. Not uncommon on the lower reaches of the Irrawaddy; Annandale states that its range extends to near the Chinese frontier.

55. Trionyx cartilagineus.

Testudo cartilaginea Boddaert, Epistola ad W. Roell, cum Tab. 1770.—*Trionyx cartilagineus*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 253, fig. (skull), and Fauna Brit. Ind. 1890, p. 15; Siebenrock, SB. Akad. Wiss. Wien, cxii (1) 1903, p. 347, and Zool. Jahrb. Jena, Suppl. 10, 1909, p. 599.

Testudo rostrata Thunberg, K. Vet.-Ak. Nya Handl. Stockholm, viii, 1787, p. 179, pl. vii (type loc. India).

Trionyx stellatus Geoffroy, Ann. Mus. Nat. Hist. Paris, xiv, 1809, p. 13 (type loc. unknown); Theobald, Proc. Asiat. Soc. Bengal, 1874, p. 79, pl. iii, and 1875, p. 176, pl. v.

Trionyx javanicus Geoffroy, l. c. s. p. 15, pl. 3 (type loc. Java).

Trionyx cariniferus Gray, Cat. Sh. Rept. 1855, p. 67, pl. xxxii (type loc. Moluccas; Brit. Mus.); Theobald, Proc. Asiat. Soc. Bengal, 1874, p. 80, pl. iv.

Trionyx ornatus Gray, Proc. Zool. Soc. 1861, p. 41, pl. v (type loc. Cambodia; Brit. Mus.).

Aspilus punctulatus Gray, Proc. Zool. Soc. 1864, p. 84 (type loc. Amboyna and Ceram; Brit. Mus.).

Trionyx phayrei Theobald, J. Linn. Soc., Zool. x, 1868, p. 18 (type loc. Arakan Hills, Bassein Dist.; Brit. Mus.); Boulenger, Cat. Chel. Brit. Mus. 1889, p. 251, fig. (skull), and Fauna Brit. Ind. 1890, p. 14; Annandale, Rec. Ind. Mus. vii, 1912, p. 166, fig. (skull).

Trionyx jeudi Gray, Proc. Zool. Soc. 1869, p. 217, fig. (skull); type loc. ? Dutch East Indies; Brit. Mus.).

Trionyx ephippium Theobald, Proc. Asiat. Soc. Bengal, 1875, p. 177 pl. v (type loc. Tenasserim; Brit. Mus.).

Carapace and plastron similar to *T. formosus*, except that the epiplastra are in contact with or narrowly separated from one another and the plastral callosities sometimes poorly developed, even in the adult.

Skull. Snout longer than the diameter of the orbit, considerably longer in the young; postorbital arch one-half to one-third (or a little more or less) the diameter of the orbit; alveolar surface of mandible with a longitudinal ridge at the symphysis.

Length of dorsal disc 700 mm.

Dorsal disc of young olive-greyish or greenish, uniform or dotted with yellow, and usually with a few irregularly disposed black spots outlined with yellow; below greyish-white. Head with yellow spots the largest of which are usually below and on the sides; limbs with smaller spots. In the adult the discal spots entirely disappear, leaving the carapace of a more or less uniform colour; the yellow spots on the top and sides of the head become less distinct, but the intervening spaces darker, so that the final result is a black reticulation upon an olive ground; the chin and neck below become whitish or greyish. The plastron is white in the male, grey in the female.

The above description of the coloration will stand for most specimens of *T. cartilagineus* from the Indo-Chinese Region, but there are variations, particularly in juveniles. The type of

T. ephippium, a juvenile, from Tenasserim, has a large, black, saddle-shaped mark upon the dorsal disc and black patches on either side of the disc posterior to it; in a specimen, one-third grown, from the Bassein District indications of these markings are still recognizable (B.M. Coll.). This form of colour-pattern is common in examples from Borneo. Most juveniles from the Malay Peninsula and Archipelago have a black Λ- or X-shaped mark on the occiput, and this mark occurs in two juveniles collected by Mouhot in Cambodia (types of *T. ornatus*). Theobald states that his *T. phayrei* (an adult) was in life of a dull dark brown colour above, handsomely marked, as in Günther's figure of *Chitra indica* (Rept. Brit. India, 1864, pl. vi).

Range. Southern Burma; Siam; French Indo-China as far north as Tonkin; the Malay Peninsula and Archipelago. It is common in Central Siam and Cambodia, inhabiting chiefly muddy slow-flowing rivers, but also ascending hill-streams for a considerable distance. It is frequently met with in the Chao Phya River in the vicinity of Bangkok, and, as far as I am aware, is the only species of *Trionyx* that inhabits that river after it enters the great central plain of Siam. Its flesh is not considered very palatable. Its eggs are deposited in holes in mud-banks; they measure 30–40 mm. in diameter.

I am unable, on the material available, to distinguish *T. phayrei* from *T. cartilagineus*. Boulenger and subsequent authors who have followed him separated it upon the degree of development of the plastral callosities and differences in the width of the postorbital arch. As already stated on p. 148, I do not regard the degree of development of the callosities as of specific value. The skull and shell of the type of *T. phayrei* agree entirely with examples of undoubted *T. cartilagineus* from Siam and the Malayan region. A good series of *T. cartilagineus* in my own collection, caught in the river at Bangkok, shows that the snout (on the skull) becomes shorter and less sloping, and the postorbital arch broader, as age advances. The latter character is comparative only, however, owing to the greater size of the orbit in the young. The age at which the plastral callosities develop appears to be variable; possibly sex is a factor in determining it.

All individuals from the neighbourhood of Bangkok that I have examined and a specimen from Pak Lai on the Upper Mekong (lat. 18° N.) have four pairs of ossifications to the body of the hyoid bone. The ossification of the fourth pair commences later than the other three, but in adult individuals it is well developed (see also p. 152).

In captivity *T. cartilagineus* feeds freely and is not timid. It soon learns to come and feed from the hand, but can never be trusted not to bite when handled.

Trionyx sinensis.

The precise status of the freshwater turtles of the Chinese region still awaits solution, and a critical examination of good series, using many more characters than are generally employed, will be required before this can be settled.

Boulenger included the majority of them under the name *sinensis*, and this view has been maintained by Siebenrock (1909). As here restricted, *sinensis* is confined to the form which is found in the extreme south of China and adjacent Indo-Chinese region.

The following combination of characters will serve to distinguish the three forms included in this work :—

T. sinensis.	*T. s. tuberculatus.*	*T. steindachneri.*
Length of mandibular symphysis greater than diameter of orbit.	Length of mandibular symphysis greater than diameter of orbit.	Length of mandibular symphysis less than diameter of orbit.
Hinder extremities of entoplastron moderately broad.	Hinder extremities of entoplastron broad and dentate.	Hinder extremities of entoplastron pointed.
Posterior cornua of hyoid apparatus broad at the base.	Posterior cornua of hyoid apparatus broad at the base.	Posterior cornua of hyoid apparatus narrow.
Dorsal tubercles more or less fused with one another in longitudinal series.	Dorsal tubercles in longitudinal series more or less discrete.	Dorsal tubercles in longitudinal series more or less discrete.
No coarse tubercles at base of neck.	Base of neck with coarse tubercles.	A prominent patch of coarse tubercles on either side of base of neck.
Plastral spots large and distinct.	Plastral spots small or absent.	Plastron uniform white or mottled with grey.

56. Trionyx sinensis (forma typica).

Trionyx (*Aspidonectes*) *sinensis* Wiegmann, Nova Acta Acad. Leop.-Carol. xvii, 1834, p. 189 (type loc. Tiger River, Macao, China).—*Trionyx sinensis*, Boulenger, Cat. Chel. Brit. Mus. 1889, p. 256 (in part); Siebenrock, SB. Akad. Wiss. Wien, cxii (1) 1903, p. 349, and Zool. Jahrb. Jena, Suppl. 10, 1909, p. 601 (in part); Mell, Arch. Naturg. Berlin, vol. lxxxviii (10) 1922, p. 110.—*Amyda sinensis*, Stejneger, Herpet. Japan, 1907, p. 524 (in part); Schmidt, Bull. Amer. Mus. Nat. Hist. liv, 1927, p. 408.

A single neural plate between the first pair of costals; costal plates well developed, the last pair in contact in the mid-line; all the plates of the carapace finely pitted and vermiculate; anterior limbs of epiplastra moderately long and

slender, separated from one another; four plastral callosities, hyo-hypoplastral and xiphiplastral, feebly developed in the adult.

Skull. Snout and mandibular symphysis distinctly longer than the diameter of the orbit; postorbital arch one-third the diameter of the orbit; alveolar surface of mandible smooth.

Dark olive-greyish above, the disc with indistinct black

Fig. 41.—*Trionyx sinensis*, ventral aspect of juvenile.

markings in the adult, usually with rounded, black, light-edged spots in the young; head above with small black spots and streaks radiating from the eyes, namely one connecting them, one extending forwards to the side of the snout, one behind on to the neck, and two or three below; chin and sides of neck usually with light, dark-edged spots, those on the neck being more or less elongate or confluent with one another. They

disappear with age. Below white with large black spots; these vary somewhat in size and shape, but the general pattern is constant; they are always present and very distinct in the young and half-grown, but disappear almost or entirely in old individuals.

Length of dorsal disc 250 mm.

Range. Southern China; Tonkin; Annam (Chang Nam Province); Hainan. The northern limit of this form is not clearly defined, but it does not appear to range far north of the West River. In that region it is common, inhabiting rivers, canals, and ponds. It is frequently sold in the markets for food.

56 *a*. Trionyx sinensis tuberculatus.

Trionyx tuberculatus Cantor, Ann. Mag. Nat. Hist. (1) ix, 1842, p. 482, and Zool. Chusan, Calcutta, 1842, pl. vi (type loc. Chusan, China; Brit. Mus.).—*Amyda tuberculata*, Schmidt, Bull. Amer. Mus. Nat. Hist. N. York, liv, 1927, p. 473.

Tyrse perocellata Gray, Cat. Tort., etc., 1844, p. 48 (subst. name for *tuberculatus*).—*Trionyx perocellatus*, Gray, Cat. Sh. Rept. i, 1855, p. 65, pl. xxxi.

Landemania irrorata Gray, Proc. Zool. Soc. 1869, p. 216 (type loc. Shanghai; Brit. Mus.).

Some of Heude's forms (see synonymy, p. 165) are probably referable to this species.

The ventral spots in this race are reduced both in size and number, and disappear earlier in life than in the typical form. Those most frequently absent are the central ones, but individuals which have none at all, even at birth, are quite common.

The coarse tubercles upon the neck are not present in all individuals, nor are they confined to a circumscribed area as in *T. steindachneri*.

Size as in the typical form.

Range. Yunnan; Central China; Formosa.

57. Trionyx steindachneri.

Trionyx steindachneri Siebenrock, Zool. Anz. xxx, 1906, p. 579, fig. (head), and SB. Akad. Wiss. Wien, cxvi (1) 1907, p. 1766, pl., and Zool. Jahrb. Jena, Suppl. 10, 1909, p. 600; Vogt, SB. Ges. Naturf. Fr. Berlin, 1913, p. 225; Mell, Arch. Naturg. Berlin, vol. lxxxviii (10) 1922, p. 110.—*Amyda steindachneri*, Schmidt, Bull. Amer. Mus. Nat. Hist. N. York. liv, 1927, p. 409.

The chief characters which separate this species from *sinensis* are set forth in the key.

Lower parts white, uniform or diffusely mottled with grey. Head with fine black streaks as in *sinensis*; in the young there is a broad, yellowish-white, black-edged, sinuous band on either side of the upper part of the neck starting from the

occiput. With age this becomes darker and less distinct but in adult individuals can still be traced.

The characteristic patch of tubercles at the base of the neck is present in quite young specimens ; in adults it is very conspicuous.

Length of dorsal disc 240 mm.

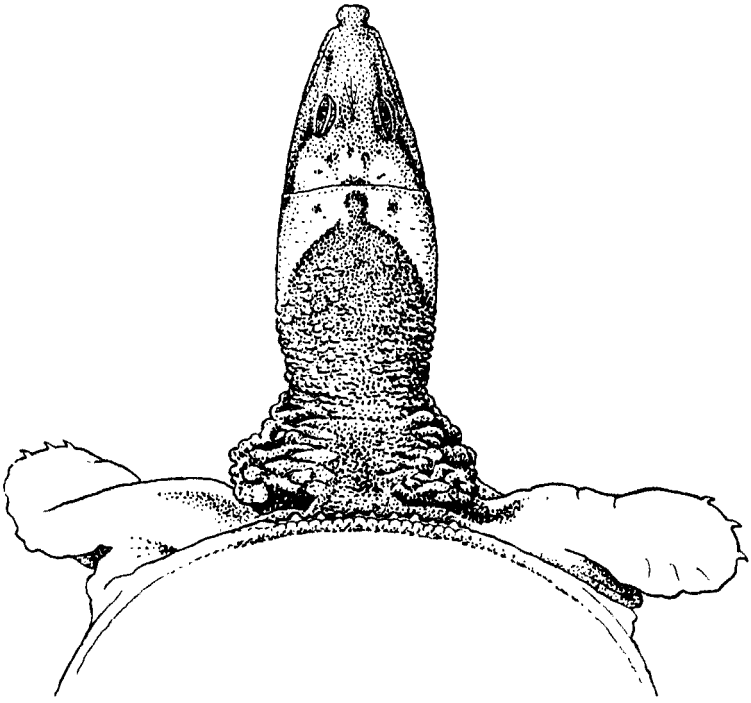

Fig. 42.—*Trionyx steindachneri.*

Range. Southern China (Kwang Si and Kwang Tung Provinces) ; Tonkin (Than-Moi and Ngoi-Tia) ; Annam (Phuc-Son, S.W. of Tourane) ; Hainan.

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PLATE I.

Fig. 1. *Siebenrockiella crassicollis.*

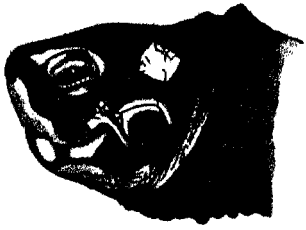
2. *Batagur baska.*

3. *Damonia subtrijuga.*

4. *Cuora amboinensis.*

5. *Geoemyda trijuga coronata.*

6. *Geoclemys hamiltoni.*



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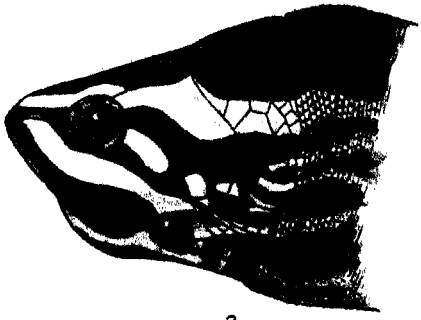

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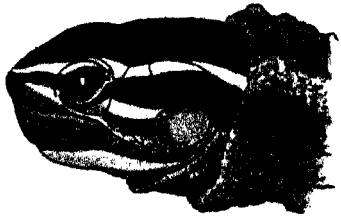

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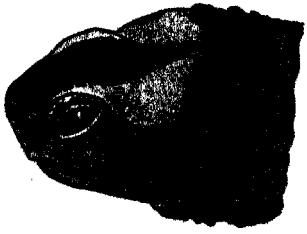

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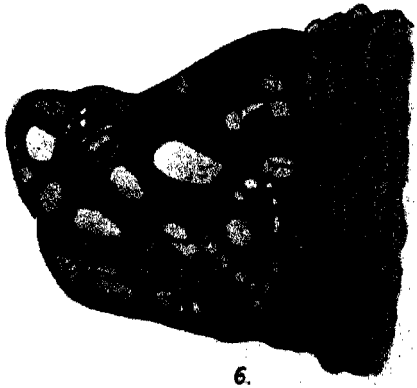

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PLATE II.

Fig. 1. *Geoemyda tricarinata.*

2. *Morenia ocellata.*

3. *Chinemys reevesi.*

4. *Kachuga sylhetensis.*

5. *Cuora yunnanensis.*

6. *Kachuga tectum.*

7. *Trionyx gangeticus* (young).

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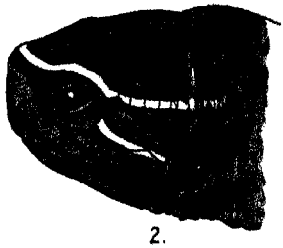

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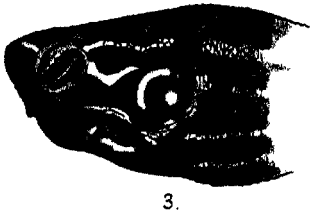

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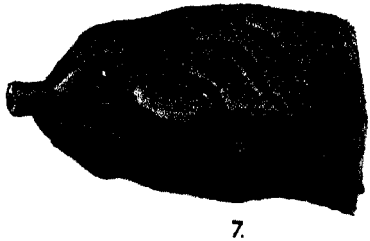

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